

## **Systems Reference Library**

### **IBM 1800 Installation Manual – Physical Planning**

This publication contains physical planning information for the 1800 system. It includes dimensions, weights, cable locations and available lengths, service clearances and other necessary physical information for each unit of the system. A proposed planning schedule and the environmental and electrical requirements are also included.

## PREFACE

This manual contains preliminary reference information for planning the installation of the IBM 1800 Data Acquisition and Control System.

In addition to the technical information needed for physical installation planning, this manual contains recommendations and suggestions to be followed in planning an efficient and reliable installation.

### Reference Publications

The following publications provide additional physical planning information for the 1800 system.

#### IBM 1800 Data Acquisition and Control System:

1. Configurator, Form A26-5919.
2. Physical Planning Template, Form X26-3573.
3. 2841/2311 Physical Planning Template, Form X22-6858.
4. Analog Input Signal Chart, Form X26-3635.
5. Analog Output Signal Chart, Form X26-3636.
6. Digital Input Signal Chart, Form X26-3637.
7. Digital Output Signal Chart, Form X26-3638.

8. Interrupt Level Status Word Assignment Form, Form 120-1241.
9. Process Interrupt Status Word Assignment Form, Form 120-1246.
10. Cable Order Form, Form 120-1331.
11. 1827 Configurator, Form A22-6872.
12. 1827 Physical Planning Template, Form X26-5508.

#### IBM System/360:

1. Installation Manual - Physical Planning, Form C22-6820.
2. Cable Order Form, Form 120-1080.

#### IBM 2790 Data Communication System:

Installation Manual - Physical Planning,  
Form A27-3017

Other publications regarding the 1800 system are listed in the IBM 1800 Bibliography, Form A26-5921.

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Significant changes or additions to the specifications contained in this publication are continually being made. Before using this publication in connection with the operation of IBM equipment, contact the local IBM Branch Office for revisions.

The illustrations in this manual have a code number in the lower corner. This is a publishing control number and is not related to the subject matter.

Copies of this and other IBM publications can be obtained through IBM Branch Offices.

A form for reader's comments is provided at the back of this publication. If the form has been removed, send your comments to the address below.

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Successful installation of a process control system requires thorough planning and continuous supervision to ensure system performance. The customer assumes responsibility for providing suitable space for the 1800 system ordered. IBM installation planning representatives are available for consultation in planning physical requirements of the installation.

In many cases, the customer will establish a pre-installation consulting and service group which includes IBM representatives, engineering consultants, and other outside consultant personnel. This group will consult with and advise the customer on the installation. The customer's management personnel will take charge of the overall operation and will coordinate physical planning with procedures, instrumentation, signal wiring, and general planning.

Suitable facilities may already exist in some customers' plants while in others it will be necessary to change existing space. In still other instances, the customer may desire to provide complete new construction. The operation should follow a planned schedule so that facilities construction, signal wiring, and instrumentation installation are complete when the system is delivered.

## SCHEDULE

Because each 1800 system installation differs in some respects from every other installation, it is not possible to provide a detailed schedule. However, the following schedule provides a basis for general installation planning.

### One Month after System Order or Not Less Than Nine Months before System Delivery

1. Determine specific instrumentation and IBM 1800 features required to meet control requirements.
2. Determine IBM 1800 features and units desired and review the order.
3. Determine the prospective location of the system and make a preliminary layout of the system. IBM provides templates for this purpose. See Preface for form numbers. Include actual machine unit and feature locations and a schematic diagram of the signal and

control cable connections between the system and the instrumentation.

4. Request a visit by the IBM installation planning representative to discuss installation, power, environmental, and signal requirements with the customer's personnel (including planning staff and consulting group).
5. Study local delivery quotations for instrumentation, signal wiring, power, and mechanical equipment to determine when orders must be placed.
6. All RPQs\* must be defined and submitted. Assigned schedules are subject to change by the addition of RPQs.
7. All requests to install non-IBM equipment, in units of the 1800 system, must be by letter of Alteration and Attachment (requires approval by the local IBM Field Engineering Manager) or by RPQ. Power distribution within units of the system is provided only for the installation and servicing of IBM units and features. Customer use of this power must be by RPQ.

Installation of non-IBM equipment within units of the 1800 system must:

- Comply with the vibration and environment specifications set forth in this manual.
- Not interfere with the service access areas of the IBM units.
- Meet IBM safety standards.

The IBM Area Installation Planning Engineer should be consulted whenever the customer desires to install non-IBM equipment in (or physically attached to) units of the 1800 system.

### Three Months after order or Not Less than Seven Months before System Delivery

1. Complete plans and specifications for instrumentation and interconnecting wiring to the 1800 system.
2. Complete customer interrupt assignment forms and submit them to the plant of control. Corrected assignment forms must be submitted whenever the original assignments will be affected by changes in the system order.

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\*Request Price Quotation from IBM.

3. Complete structural, mechanical, and electrical facility design specification. Submit invitations for bids to outside contractors as required.

#### Four Months before System Delivery

1. The final machine-unit layout should be made by the customer. After approval by the customer, branch manager, and field engineering manager, necessary cables will be placed on order by the IBM branch manager. Assistance by IBM installation planning representatives will be provided when requested.
2. Review plans and specifications for instrumentation and for signal and control wiring. Contracts for new or modification work should be let and construction started.
3. Orders for IBM supplied interunit cables should be received by the IBM plant of order control.

This is the critical point in the schedule. After this date, layout changes affecting cable lengths or component location within units of the 1800 system will be considered on an RPQ basis.

#### One Month before System Delivery

1. Facilities construction should be in the final stage.
2. Instrumentation and customer provided signal and control wiring should be in the final installation phase and instrumentation check-out should be in process.
3. Final review of pre-installation planning should be completed.
4. Specific requirements for moving system components from the loading dock or staging area to the installation sites should be determined.

#### One to Two Weeks before System Delivery

1. Interunit connecting cables supplied by IBM and shipped separately from the system will be delivered to the installation site to be set in place by customer personnel under supervision of IBM Customer Engineers. It is the responsibility of IBM to connect the interconnecting cables to any IBM components.
2. Customer-provided wiring or cable assemblies for connection of process instrumentation or process input/output units should be installed, and ready to be terminated. Designated customer access areas are provided for customer termination and installation of wiring at the rear of

1800 units. Connection of customer wiring in or on these units is the responsibility of the customer.

3. All mechanical, electrical power, and structural construction work should be completed, tested, and ready for operation.

#### SITE SELECTION

The 1800 system is designed for installation in or near the control area of most processes. Selection of the actual site location will depend upon signal control wiring, availability of space and utilities, and the interrelationship of the control system with other process control functions. Selection of a site free from high concentrations of atmospheric contamination is recommended.

#### BUILDING REQUIREMENTS

Safety is a vital factor in planning for a large computer installation. This consideration is reflected in the choice of a computer location, building materials used, fire prevention equipment, air conditioning and electrical systems, and personnel training.

#### Fire Prevention Equipment in a Computer Area

1. Portable carbon dioxide fire extinguishers of suitable size (15 pounds) and number should be provided in the machine room. This is the recommended nonwetting agent for electrical equipment (Class C Hazard).
2. Where portable carbon dioxide cylinders are used as the primary extinguishing agent, it is advisable to locate a standpipe or hose unit within effective range of the computer area as a secondary extinguishing agent for a Class A Hazard.

#### Floor Construction

Size and weight of individual units in the system are such that floor and structural-member load ratings of most office and plant-type buildings are not exceeded when recommended machine-unit service clearances are maintained. The weight of each unit is listed in the specification summary. A raised floor is not required but may be used if desired. When used, a raised floor will accomplish the following objectives:

1. Allow future layout change with minimum reconstruction cost.

2. Conceal the interconnecting cables and power receptacles.
3. Provide personnel safety.
4. Permit the space between the two floors to house air supply ducts or act as an air plenum if desired.

A raised floor can be constructed of steel, aluminum, or fire resistant wood. The free access type of floor, in which the floor rests on pedestals, is preferred rather than the raceway type, whenever permitted by local building codes. The two general floor types and a cable ramp illustration are shown in Figure 1.

IBM recommends that there be no metal exposed to the walking surface where a raised floor using metal is used. Such exposure is considered a safety hazard.

When selecting a raised floor covering, consider such factors as the frequency of moving machine units, minimum cracking or dusting of the tile, appearance, and cost.

Some floor covering materials contribute to static electrical charge buildup on personnel and furniture. Selection of floor covering material which has a resistance to building ground between .5 megohms to 20,000 megohms will minimize static buildup and provide adequate resistance for personnel safety.

#### Room Construction

Normal office or control-room type construction using fire resistant or non-combustible material for walls, ceilings, and flooring in the area where the main process control system and data processing input/output units are to be installed is recommended.

#### Supplies Storage

Any data stored in the computer room – whether in the form of magnetic tape, paper tape, cards, or paper forms – should be in enclosed metal cabinets or fire-resistant containers.

#### Service Area

A minimum area of 100 square feet (approximately 10' x 10') should be provided for the use of servicing personnel, storage of test equipment, and storage of parts. This area should be located in the general vicinity of the main process control system. If the system is installed on a raised floor, the service area should be at the same level or access ramps should be provided.

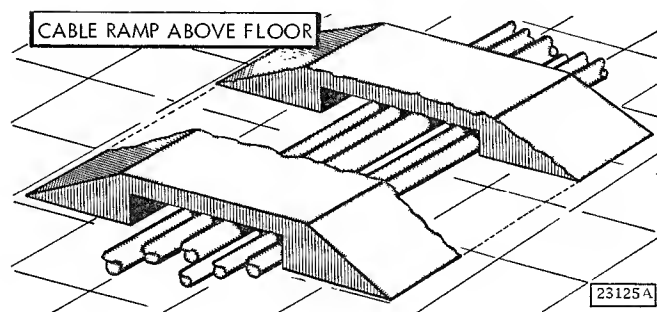
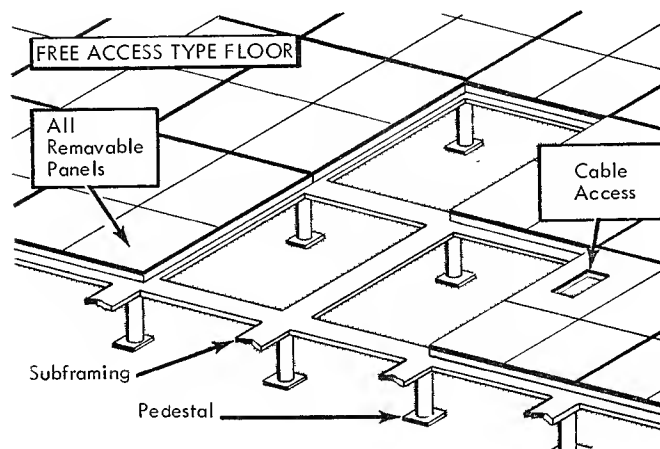
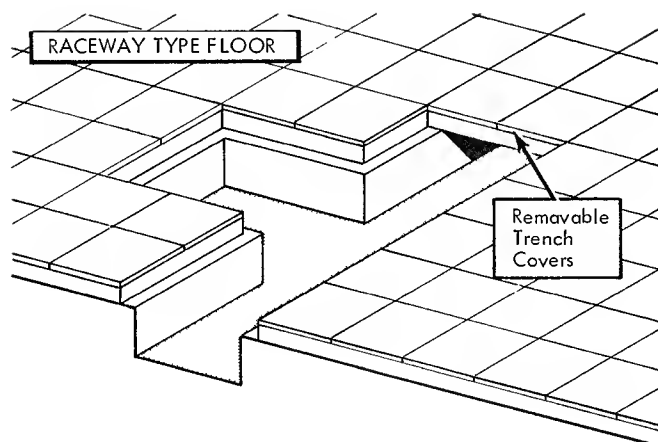


Figure 1. Floor Types and Cable Ramps

## ENVIRONMENTAL CONDITIONS

### Temperature and Relative Humidity Limits

When a group of units share a common environment, environmental specifications are determined by the unit having the narrowest range of limits. Units of the 1800 system will operate reliably if the ambient air conditions do not exceed the limits as shown in Table 1. Optimum design conditions are 75°F (24°C) and 40 to 50% relative humidity.

**Note:** The conditions shown in Table 1 for machine power on must exist at the time power is turned on.

Refer to Analog Performance Terminology in Section 5 for temperature coefficient and detailed AI specifications.

Under all conditions of operation, input air should not exceed operational period specifications. These are maximum operation condition specifications and should not be considered as design conditions.

Condensation must not be permitted on the components of the system.

### Supplies Storage Area

Supplies	Temperature	Rel. Hum.
Magnetic Tape: Heavy Duty Mylor*	40° to 90°F (4.4° to 32.2°C) 50° to 90°F (10° to 32.2°C)	20 to 80% 20 to 80%
Cards	50° to 90°F (10° to 32.2°C)	30 to 65%
Paper Forms: Continuous Sheet-Fed	50° to 100°F (10° to 37.8°C) 50° to 100°F (10° to 37.8°C)	20 to 65% 20 to 65%
MICR Tape	60° to 100°F (15.6° to 37.8°C)	
Expendable Typewriter Supplies	50° to 100°F (10° to 37.8°C)	20 to 65%
* Trademark of (E.I. du Pont de Nemours Company)		

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Before a disk pack or cartridge is used it should be conditioned to the machine-room temperature for two hours prior to use. The ideal environment for disk packs and cartridges is the same as that recommended for the machine. The conditioning time is required to ensure correct track registration and data recording and retrieval.

These devices are equipped with protective covers which should be left in place and closed except when installed on the machine.

Magnetic fields greater than 50 oersteds can cause loss of data or introduction of noise.

Additional information concerning handling, operation, shipment and physical characteristics of the disk cartridge is in: IBM Disk Pack and Cartridge Handling Procedures, Form A26-5756.

Table 1. Temperature/Relative Humidity Requirements

	Operational Period-Machine Power ON			Non-Operational Period-Machine Power OFF		
	Temperature	Relative Humidity	Maximum Wet Bulb Temperature	Temperature	Relative Humidity	Maximum Wet Bulb Temperature
A. 1801, 1802, 1826, 1827, and 1828 units	40 to 122°F * (4.4 to 50°C)	8 to 95%	85°F (29.4°C)	40 to 122°F (4.4 to 50°C)	8 to 95%	85°F (29.4°C)
B. 1803 unit	40 to 105°F (4.4 to 41.6°C)	8 to 95%	85°F (29.4°C)	40 to 122°F (4.4 to 50°C)	8 to 95%	85°F (29.4°C)
C. 1442, 1443, 1627, 2401, and 2402 units	60 to 90°F (15.6 to 32.2°C)	20 to 80%	78°F (25.6°C)	50 to 110°F (10 to 43°C)	8 to 80%	80°F (26.7°C)
D. 1053, 1054, 1055 and 1816 units	50 to 110°F (10 to 43°C)	10 to 80%	80°F (26.7°C)	50 to 110°F (10 to 43°C)	10 to 80%	80°F (26.7°C)
E. 1810 unit	50 to 105°F (10 to 41.6°C)	8 to 80%	85°F (29.4°C)	50 to 105°F (10 to 41.6°C)	8 to 80%	85°F (29.4°C)
* 40 to 105° F (4.4 to 41.6° C) if unit contains: Communications Adapter, Selector Channel, 2790 Adapter, or Expanded Data Channels.						

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## Air Conditioning

Components of most units of the system are internally cooled by blower-circulated air. Dust filters are provided at each air input. Warm air exhausts from the top of each unit.

IBM recommends installation of an air conditioning system to maintain control of temperature, humidity, air contamination and for personnel comfort and optimum system performance.

Heat loads generated by the 1800 system are relatively small. Machine heat dissipation loads are given on the specification pages for each unit and in the specification summary.

To determine the air conditioning capacity necessary for a complete installation the following factors must be considered; machine heat dissipation, personnel, latent load, fresh air introduction, machine room sensible heat load, and lighting. Optimum design conditions are 75°F. (24°C.) and 40 to 50% relative humidity. This design provides the largest buffer, in terms of system operation, if the air conditioning fails or malfunctions. Under normal operation this design condition can be controlled within limits of  $\pm 2^\circ\text{F}$ . ( $1^\circ\text{C}$ .) and  $\pm 5\%$  relative humidity with standard air-conditioning controls.

## Room Pressurization

Make-up air should be brought into the air conditioning system to maintain a positive pressure within the 1800 system room. A pressure of approximately 0.1 to 0.2 inches (0,254 to 0,508 cm) of water above that of the surrounding environment is usually sufficient. The source of this air should be as free from particulate and gaseous contamination as possible. Air volume should be kept to a minimum, consistent with good engineering practice for pressurization and oxygen content.

## Air Filtration

Particulate Filtration: A filter rated according to the following specifications should be installed to filter air to the computer room.

Mechanical and electrostatic air cleaners operate on two entirely different principles, therefore, it is necessary to specify a different efficiency rating for each type.

1. **Mechanical Air Filter:** This type must be rated at a minimum of 20% efficiency by the Bureau of Standards discoloration test using atmospheric dust. This rating applies to a clean filter and must be maintained throughout the life of the filter.
2. **Electrostatic Plate Type Filter:** This type must be rated at a minimum of 85 to 90% efficiency by the Bureau of Standards discoloration test using atmospheric dust.

Special filtration is necessary where installations are exposed to corrosive gases or liquids, salt air, or unusual dirt or dust conditions.

## Atmospheric Contaminants

Many industrial processes increase the amount of particulate and liquid or gaseous material in the atmosphere. These materials can affect system performance by increasing wear of mechanical parts and chemical corrosion of components, thus exposing the system to excessive maintenance activity or to premature end-of-life.

These harmful elements can be reduced to levels which minimize the exposure to the 1800 system or its units by implementation of the following recommended guides:

1. Gaseous Filtration: When filtering is necessary to remove gases, all air handled by the air conditioning system, (make-up and recirculated) should pass through a chemical control filtration system such as an activated carbon filter. The number of filter stages and the arrangement of the filters will be dictated by the conditions at a particular location and the filter media selected.

When activated carbon filters are used, each stage should contain a minimum of 40 to 45 pounds of carbon per 1000 cfm of air handled. Special impregnation for specific gases is readily available. This impregnation significantly improves retentivity of the activated carbon filter media for the specific gases. These filters are readily available and their use should be considered. Proper installation and maintenance of these filters is essential. This includes the use of high efficiency particulate filters (rated at a minimum of 85% efficiency by

the Bureau of Standards discoloration test using atmospheric dust) ahead of the activated carbon.

2. Relative Humidity: Control is essential to reduce the rate of corrosion. Relative Humidity should be limited to 50% with efforts made to control to 35%.
3. Room Maintenance: The area should be kept clean and free of particulate contaminants. Personnel traffic should be minimized through the area. The use of a vestibule with door closers, as an air lock, should be considered.
4. Facility Support Maintenance: The customer must institute an active and aggressive maintenance program, particularly with respect to filter maintenance and humidity control.

#### Recorders and Indicators

Temperature/relative humidity recorders, room and filter pressure manometers should be installed to permit rapid determination of the history of these parameters.

#### Lighting

A minimum average illumination of 40 foot-candles measured at 30 inches above the floor should be maintained in the general machine room area or at remote locations where printed material is to be used by operator personnel.

Direct sunlight should be avoided, since lower levels of illumination are necessary to observe various console and signal lights. Lighting should be sectionally controlled by switches so that the general illumination level can be reduced as desired.

#### Vibration

The 1800 system will be installed in many locations where it is subject to minor vibrations. Usually the intensity of vibrations in the normal control room environment is well below the allowable limits for the 1800 system.

Vibration can be either sustained (5 seconds or longer duration) or intermittent (less than 5 seconds duration). Three terms are commonly used to specify vibration intensity: frequency in cycles per second, amplitude in inches (rms, peak, or peak-to-peak), and acceleration in G's (rms or peak). The relationship between these factors is  $G = 0.103 A F^2$  where  $A$  is the displacement in

inches from the mean and  $F$  is the frequency in cycles per second.

The maximum allowable source vibration intensities for the 1801, 1802, 1803, 1826, 1827, 1828, 1810, 1816, and 1053 as applied to the mounting structure of each unit are:

1. Sustained vibration at frequencies less than 14 cps, 0.0035 inches rms (0.01 inches peak-to-peak).
2. Sustained vibration at frequencies of 14 cps and higher, 0.07 G rms (0.1 G peak).
3. Intermittent vibration at frequencies less than 7 cps, 0.035 inches rms (0.1 inches peak-to-peak).
4. Intermittent vibration at frequencies of 7 cps and higher, 0.18 G rms (0.25 G peak).

For units not floor mounted, the customer will consider the potential translation and amplification of G forces in the mountings he provides so as to assure that these specifications are not exceeded.

The specified limits for source vibration intensity for all 1800 system units are usually not exceeded for:

1. Sustained vibrations that are perceptible, but not annoying or distracting.
2. Intermittent vibrations that are annoying or distracting, but not intolerable. When in doubt, accurate measurements should be made.

#### Hazardous Locations

The 1800 System is not designed for installation in hazardous locations as described in NEC 70 Article 500. Where installation in such locations is encountered it is recommended that the control room be air purged or otherwise declassified.

### PRIMARY ELECTRICAL POWER REQUIREMENTS

#### Specifications

1801, 1802, 1827: - 208/230 vac (+10%, -8%).  
60 ( $\pm 1/2$ ) cycle per second, three-phase.

These units are available for use in countries using 50 cycle power sources with the following specifications: 195, 220, 235, 380, or 408 vac (+10%, -8%); 50 ( $\pm 1/2$ ) cycle per second; 3 phase.

1053, 1816: - 208/230 vac ( $\pm 10\%$ ) at 60 ( $\pm 1/2$ ) cycle per second, or 115 vac ( $\pm 10\%$ ) at 60 ( $\pm 1/2$ ) cycle per second. The 1053 and 1816 are avail-

able for use in countries using 50 cycle power sources with the following specifications: 112.5, 123.5, 195, 220, or 235 vac ( $\pm 10\%$ ); 50 ( $\pm 1/2$ ) cycle per second; single phase. If the 1053 and/or 1816 is in the same room as the system, it should be powered from the same source and be consistent with the system voltage.

#### Power Failure Protect Circuit

This circuit ensures proper cycling down after loss of input power. It senses the loss of power in one or more of the three input phases.

The processor-controller remains in the power-on state for power outages up to one cycle in duration. The power failure sequence enables the processor to complete the core storage cycle in process at the time of power failure.

#### Power Distribution (60 Hz Figure 2 – 50 Hz Figure 3)

Installation of a separate isolation transformer fed from the highest primary source readily available is recommended. The isolation transformer should have taps on both the primary and secondary sides so that power line and load variations can be compensated.

Both the isolation transformer and its feeding line should have capacity sufficient to handle initial start up current lasting approximately 10 cycles and still maintain output voltage regulation within the operation specifications.

The isolation transformer should be located as near to the system as possible. Distances of less than 100 feet are preferable.

No leads other than the control system leads should be connected to the transformer secondary. In some installations where devices containing arcing contacts and/or large inductive loads are connected to the transformer primary feeder, it may be necessary to provide additional electrical isolation through the use of the line filters or a motor alternator set. The power feeder to the system should be protected by a main line circuit breaker. Individual branch circuits should be protected by circuit breakers derated according to manufacturer's specifications. The circuit breaker panel should be located in an unobstructed well-lighted portion of the machine room; preferably near an exit door. Branch circuits should terminate within 10 feet of the 1801, 1802, and 1827, and within 6 feet of the 1816 or 1053 units. Rigid conduit or metallic shielding is recommended for maximum isolation from electrical noise.

1053 units located outside the 1801 or 1802 area can be powered from a separate power source.

#### Grounding (60 Hz Figure 2 – 50 Hz Figure 3)

Each input power cord supplied with the 1800 system is equipped with a grounding type-plug. An insulated equipment grounding conductor is connected between the machine frame ground and the grounding pin of the power cord plug. Each equipment grounding conductor should be connected to a common grounding conductor at the room Power Distribution Panel through the customer's branch circuits. This common grounding conductor shall then be carried directly to the nearest stable grounding electrode.

This grounding method provides a common electrical reference plane for high-speed low-level electronic signal circuitry (both customer instrumentation and IBM system), a low impedance shunt path for high frequency electrical noise filtration provided with the 1800 system, as well as equipment safety ground.

All grounding conductors should be insulated. The grounding system should be electrically isolated from power distribution grounded neutral conductors except for such interconnections as may be required by local code and safety regulations. Conduit must not be used as the only grounding medium.

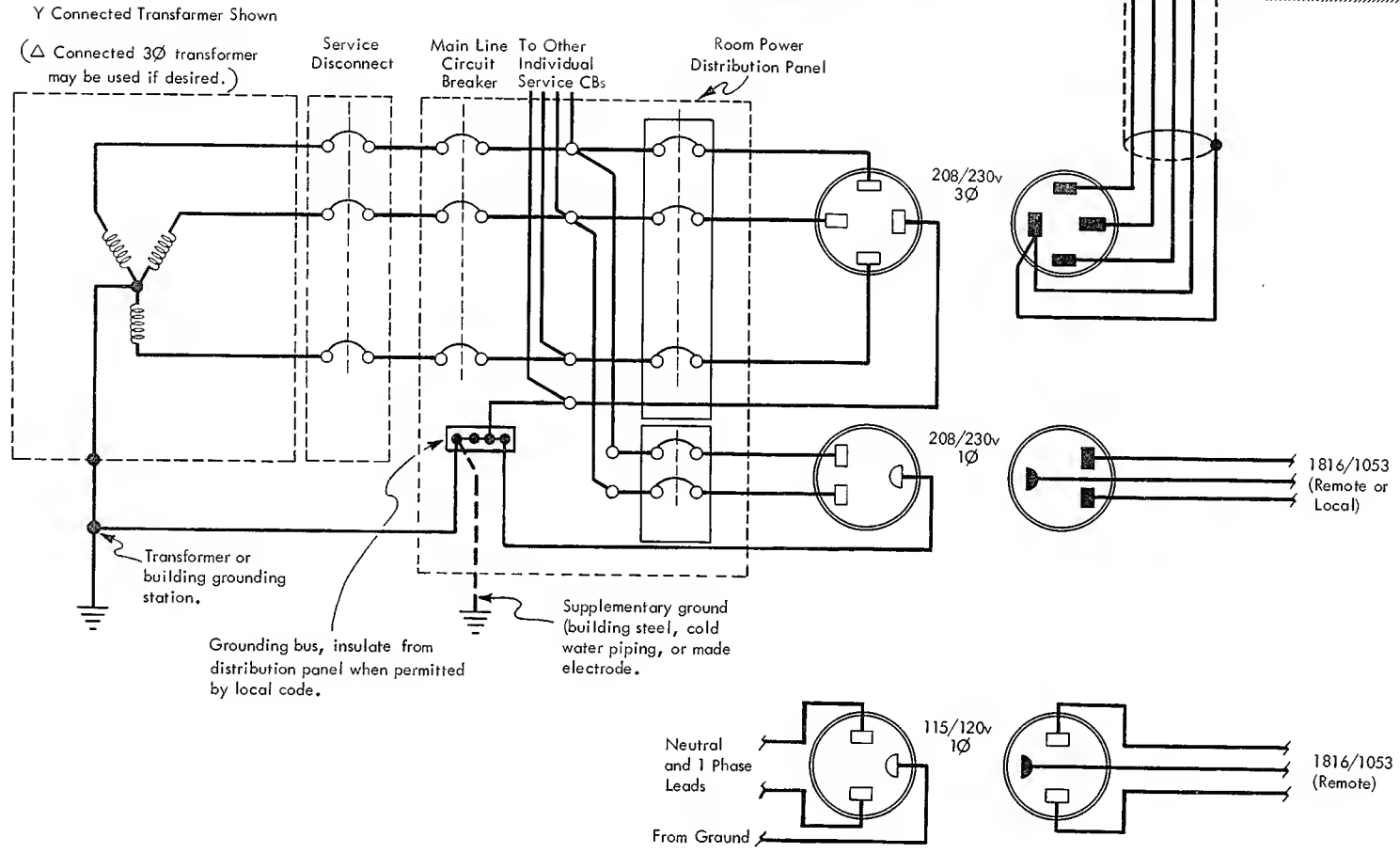
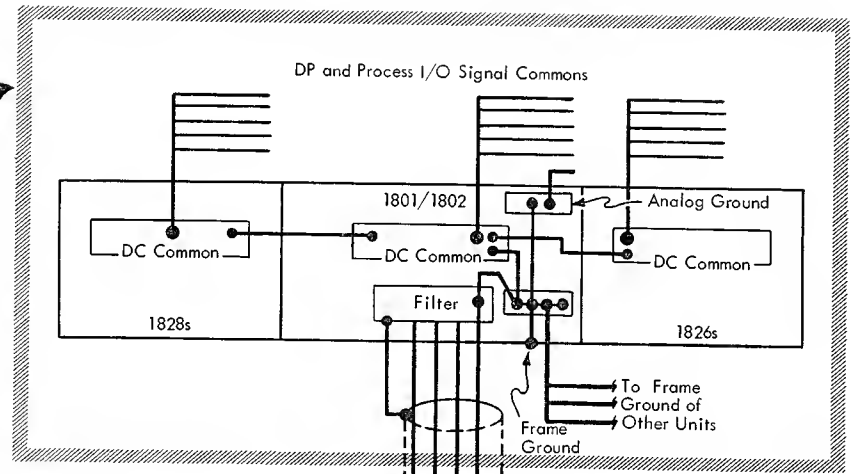
#### Grounding Electrode Types

Underground Cold Water Piping System: May be used when no nonmetallic couplings are used in the piping system and no electrical current flow is induced on the piping system from other equipment.

Building Steel Framing: May be used if bonded joints are used in construction. Use of building steel should be avoided if electrical current flow can be induced by other equipment.

Note: Resistance measurements should be taken to ensure electrical continuity of the grounding system.

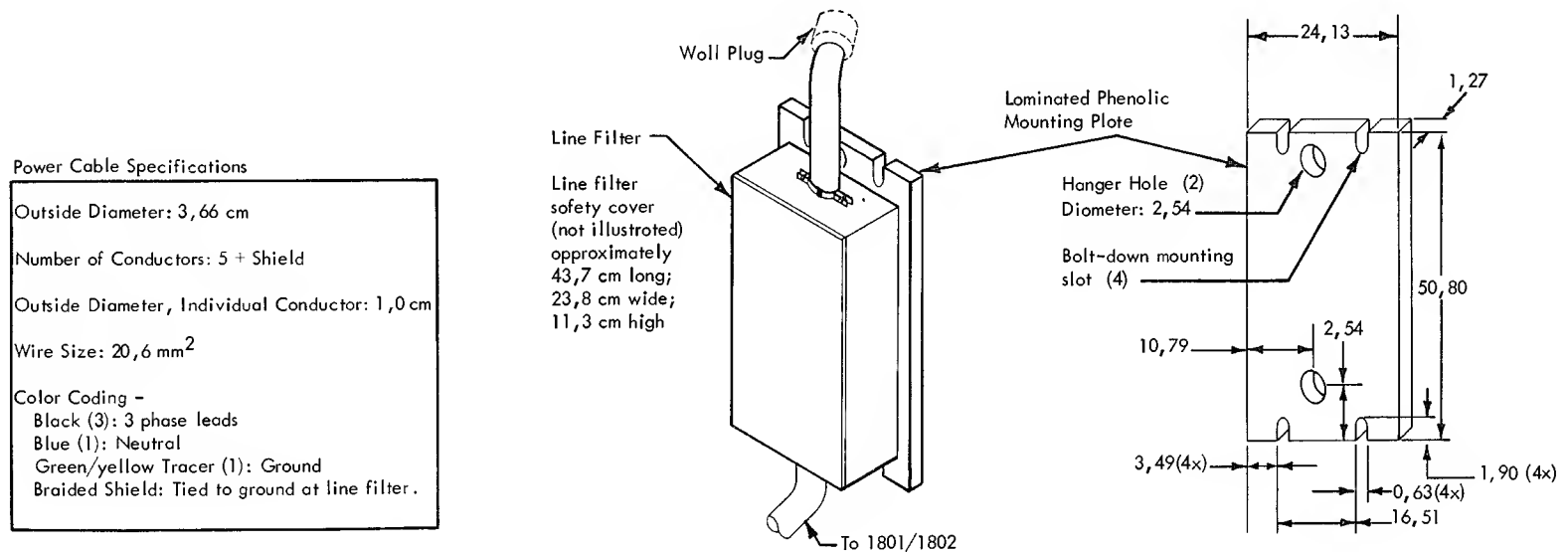
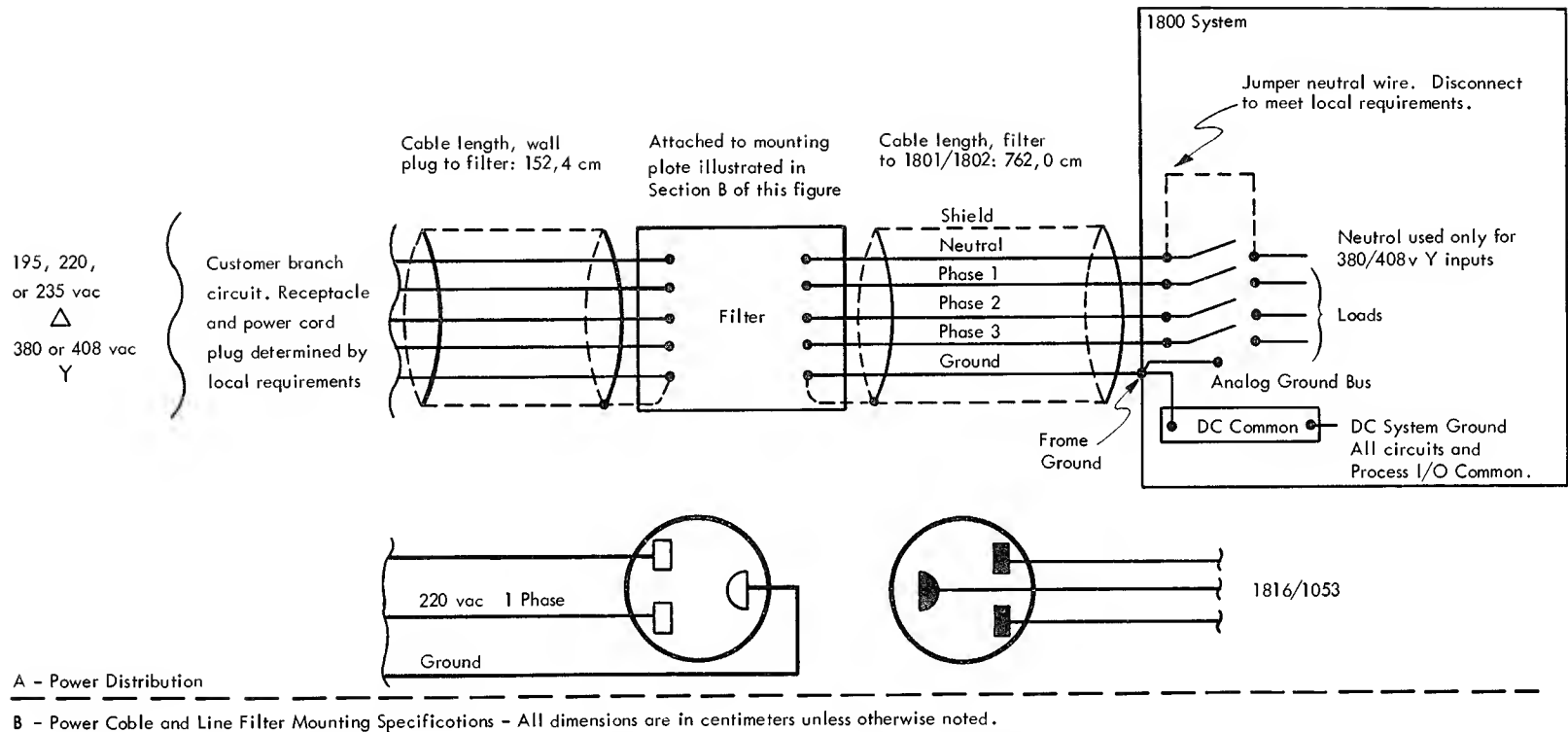
Made Electrodes: A driven rod, 0.625" (1, 5 cm) or larger, driven into permanently moist earth to a minimum depth of 12 feet (3, 5 m) or direct burial metallic plate, grid or mesh equivalent to 16 square feet (1, 5 m<sup>2</sup>) embedded in permanently moist earth can be used.



23126D

Figure 2. 1800 System Power Distribution and Grounding (60 Hz)

Figure 3. 1800 System Power Distribution and Grounding (50 Hz)



23219A

"Made Electrode" resistance to earth may be improved by the addition of charcoal or non-reactive salt around the electrode. A resistance to ground of less than three ohms is recommended. Supplementary or separate (where permitted) grounding electrodes should be located as far from other grounds and as close to the 1800 system as practical. A spacing of less than 50 feet from the 1800 system and at least 50 feet (15 meters) from other grounding electrodes is recommended.

All connections should be protected from corrosion. Welded construction is preferred. Any mechanical connections (bolts, etc.) should be accessible for periodic inspections.

#### Internal System DC Grounding

Analog Input Multiplexer/Relay inputs are isolated from dc system ground. All other signal circuits, 1800 system or external, are connected to a common dc reference point. The use of multiple grounding points on input signal wiring should be avoided as these can create voltage differences that will cause electrical noise.

Modern high-speed low-level circuits are particularly susceptible to electrical noise transients, often of microsecond duration, entering the system on signal lines, power lines, or grounding media. Selective filtering and decoupling methods have been employed to minimize the susceptibility of the 1800 system. Whenever filtering is done, the noise is shunted to the grounding circuit which provides a short circuit to these transients. Conductors that are effective short circuits to dc may present high impedance to high frequency electrical noise. The installation should suppress, shield, or isolate by placing on separate circuits any arcing contacts or similar devices which create such interference. Since it is rarely possible to achieve complete suppression or isolation, the grounding system must provide minimum impedance to a stable reference plane such as moist earth. The grounding system should have sufficient isolation from electrical noise sources so that it will not be the medium for transmitting electrical noise into the system.

#### Phase Rotation

The three-phase power receptacle must be wired for proper phase rotation. Looking at the face of the receptacle and running counterclockwise from the grounding pin, the sequence will be phase one, phase two, and phase three.

#### Lightning Protection

Installation of lightning protection on the customer's power secondary is recommended if any of these conditions exist:

- Primary power is supplied by an overhead power service.
- The area is subject to electrical storms or equivalent-type power surges.
- Lightning protection is installed on the primary power service.

Lightning protection should also be installed on all signal lines that are exposed to lightning.

Signal lines that are run in grounded metal conduit or metal enclosed raceway, grounded at intermediate points, should provide sufficient protection.

#### Convenience Outlets

A suitable number of convenience outlets should be installed in the computer room and the CE room for use by building maintenance personnel, customer engineers, etc.

#### CONTROL SYSTEM CONFIGURATOR

The IBM 1800 Configurator is designed to assist the user in determining the prerequisites, capacities, and options of the 1800 system. The data processing I/O features are at the top of the page; process I/O features appear at the bottom of the page. To use the configurator, first determine which feature is desired, then follow the arrows to the processor-controller. For example, let us assume that the digital input feature is desired. Figure 4 is an example of the configurator layout and illustrates the path to be followed for determining the prerequisites for digital inputs (Voltage).

Beginning at the bottom of Figure 4, we find that each DI (V) group is obtained by ordering one #3286, or #3287 if the group is to be high speed. Next, specify one Digital Input Adapter (DIA) #3262 for up to 8 groups of digital inputs. Over 8 groups of digital input require additional adapters (#3262). The next two steps indicate the unit and system capacity for digital input adapters. The dash line through the 1826 indicates that the DIA(s) can be installed in these units or in the 1801.

The Digital Input Data Channel (#3291) and the data channel, installed in 1801/1802, are

optional for attaching digital inputs to a specific data channel.

## SAMPLE CONFIGURATIONS

The configurations shown in Figures 5, 6, and 7 constitute examples of small, medium, and large IBM 1800 Data Acquisition and Control System installations. To develop a configuration for a particular installation it will be necessary to consider the available cable length as well as the dimensions for each unit. Information on cable length can be found in Figure 9.

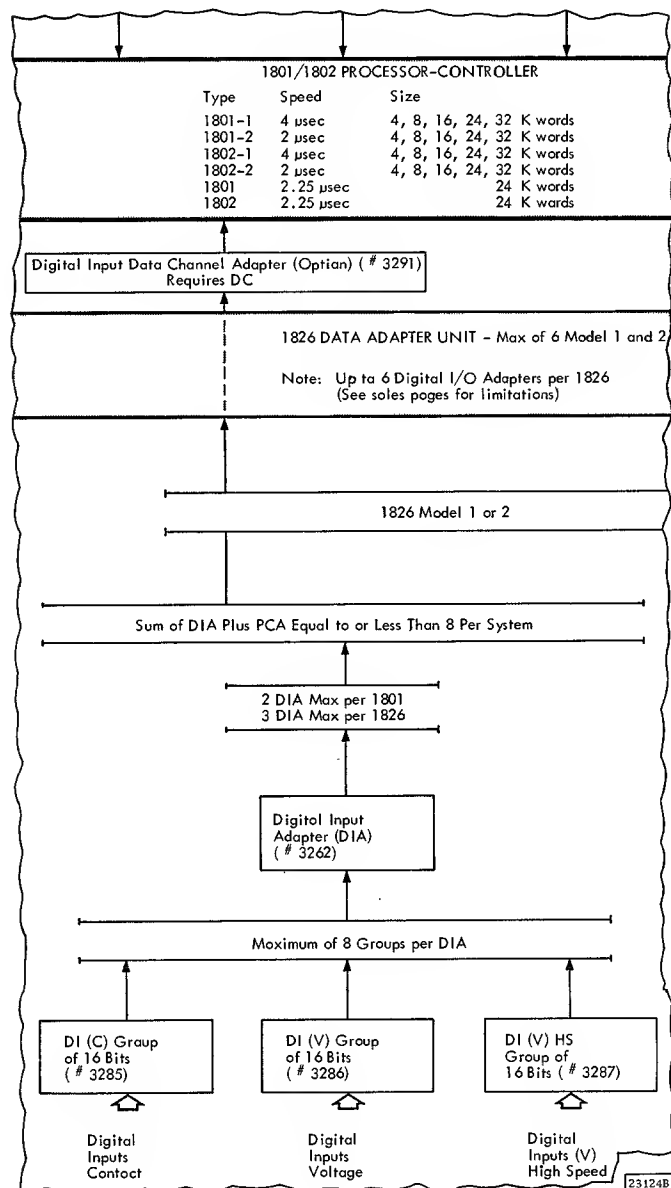


Figure 4. Finding Prerequisites for Digital Inputs Using Configurator

## CABLES

IBM will supply the necessary cables for the initial installation as specified in Figures 8 and 9. The cables are custom-made to the lengths required for each installation. Cables are measured from the base of one machine to the base of the machine they connect. To compute the cable length required between units, measure from the center points of the cable hole locations in question. In the interest of best electrical design, all cable lengths should be kept as short as possible. Orders for cables that exceed the maximum lengths specified for the system must be accompanied by an approved RPQ.

External interconnecting cables should be protected from mechanical injury in a manner that will not present a safety hazard to operating personnel. Raised flooring, cable trenches, or ramp covers can be used for this purpose.

Cable orders must be placed with the plant from which the equipment was ordered. This cable order must be in the plant 120 days prior to machine delivery.

The cables required for new and/or additional equipment will be supplied in accordance with the above. If components of the system must be moved to permit installation of new components and/or systems into the installation, those cables necessary to permit the move will be supplied at no charge. An explanation of why the cables are required must accompany the cable order. All replaced cables must be returned to the factory.

Any cables requested for reasons other than the above, such as those the customer requests for a layout revision after installation or cables for special equipment, will be considered on an RPQ basis.

### 1053 Cables

Eight-foot lengths of 1053 cable (group #22) are supplied at no charge. Lengths greater than 8' (2, 4 m) are priced per foot for cables up to a maximum of 2,000 feet (609 m). If customer supplied cable is to be used in lieu of IBM cable, the following specifications must be adhered to:

1. 30 individual conductors (twisted pair not recommended); planetary lay is satisfactory.
2. Maximum resistance per line to 1053 load = 15.4 $\Omega$
3. Line capacitance = not critical  
Maximum insulation = 300 v
4. The IBM-supplied cable consists of 37 conductors (30 used), AWG #18 (0, 824 mm<sup>2</sup>) stranded.

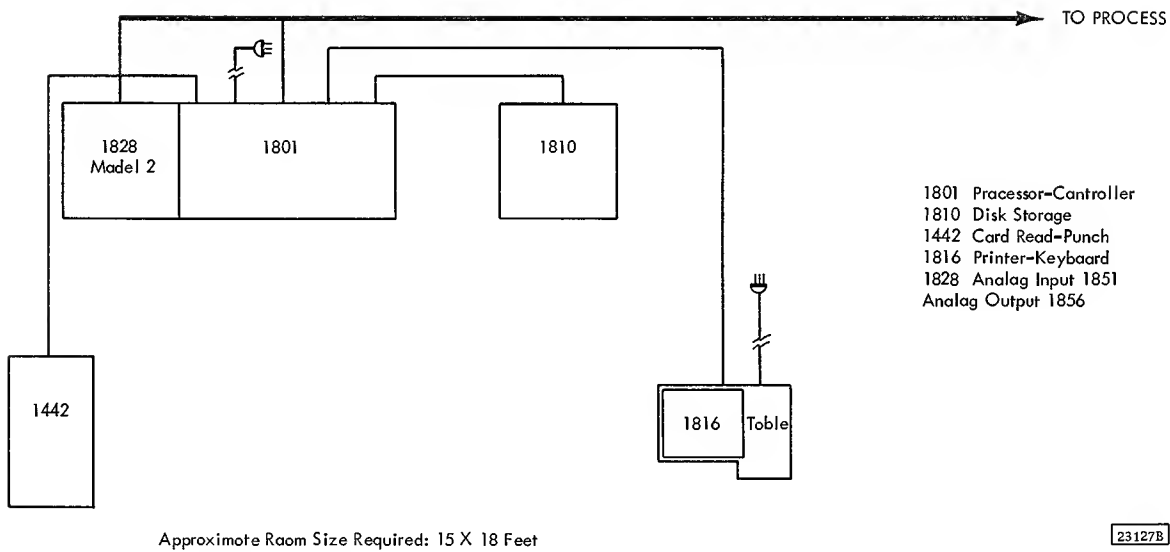


Figure 5. Sample Configuration (Small)

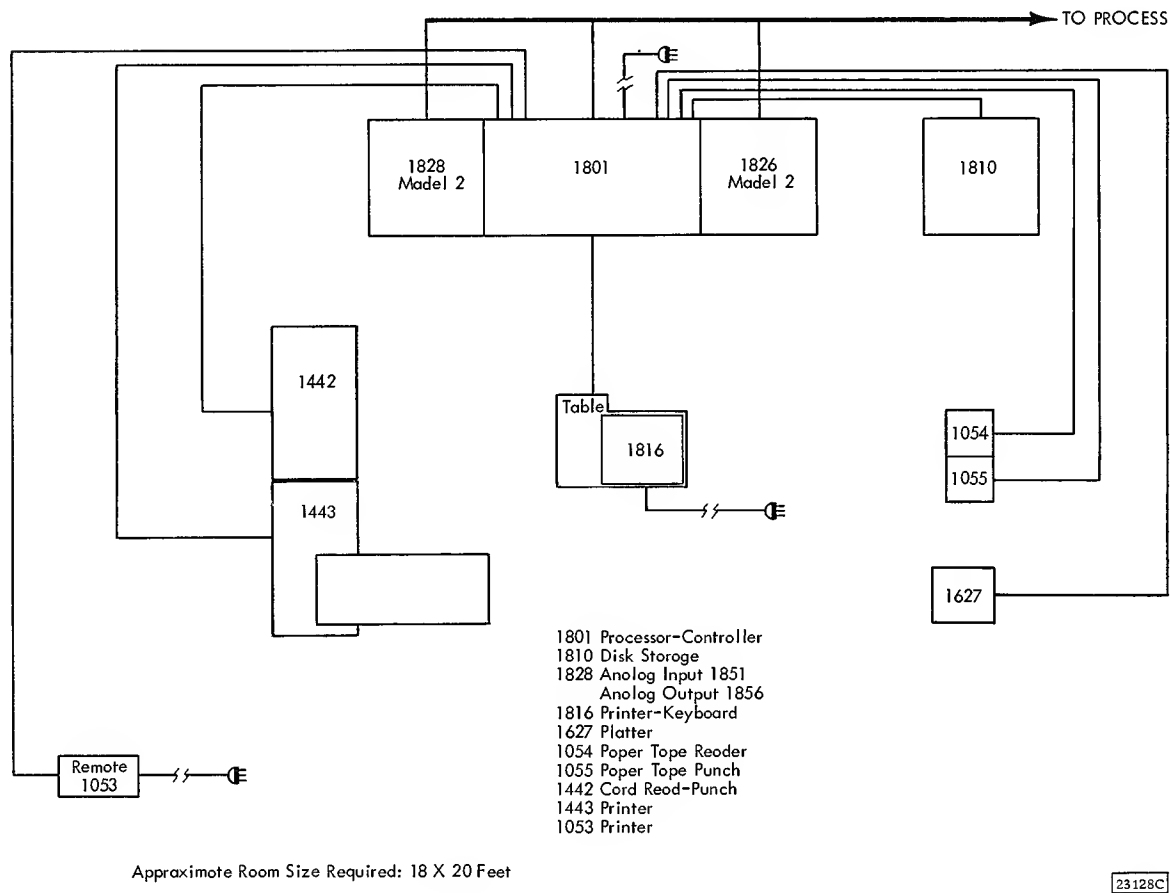


Figure 6. Sample Configuration (Medium)



Short length cables, for connection to customer-supplied cables, are available from IBM by special order (RPQ), or the customer may cut the IBM cable and provide suitable junction(s) to reconnect the cable.

### 2790 Cables

Refer to IBM 2790 Installation Manual -- Physical Planning, Order No. GA27-3017 for detailed cable requirements. The 2790 Extended Distance Repeater (EDR) features can be applied between area stations, but EDR is not available for installation in an 1826.

### Cable Connectors

Figure 10 shows the cable connectors used in the 1800 system. The dimensions given for the connectors are maximum overall measurements and may be used in calculations concerning sub-floor clearances.

### Floor to Frame Clearance

The minimum floor-to-frame clearance (standing on casters) is 4 inches (10, 1 cm) for the 1801, 1802, 1826, 1827, and 1828 units.

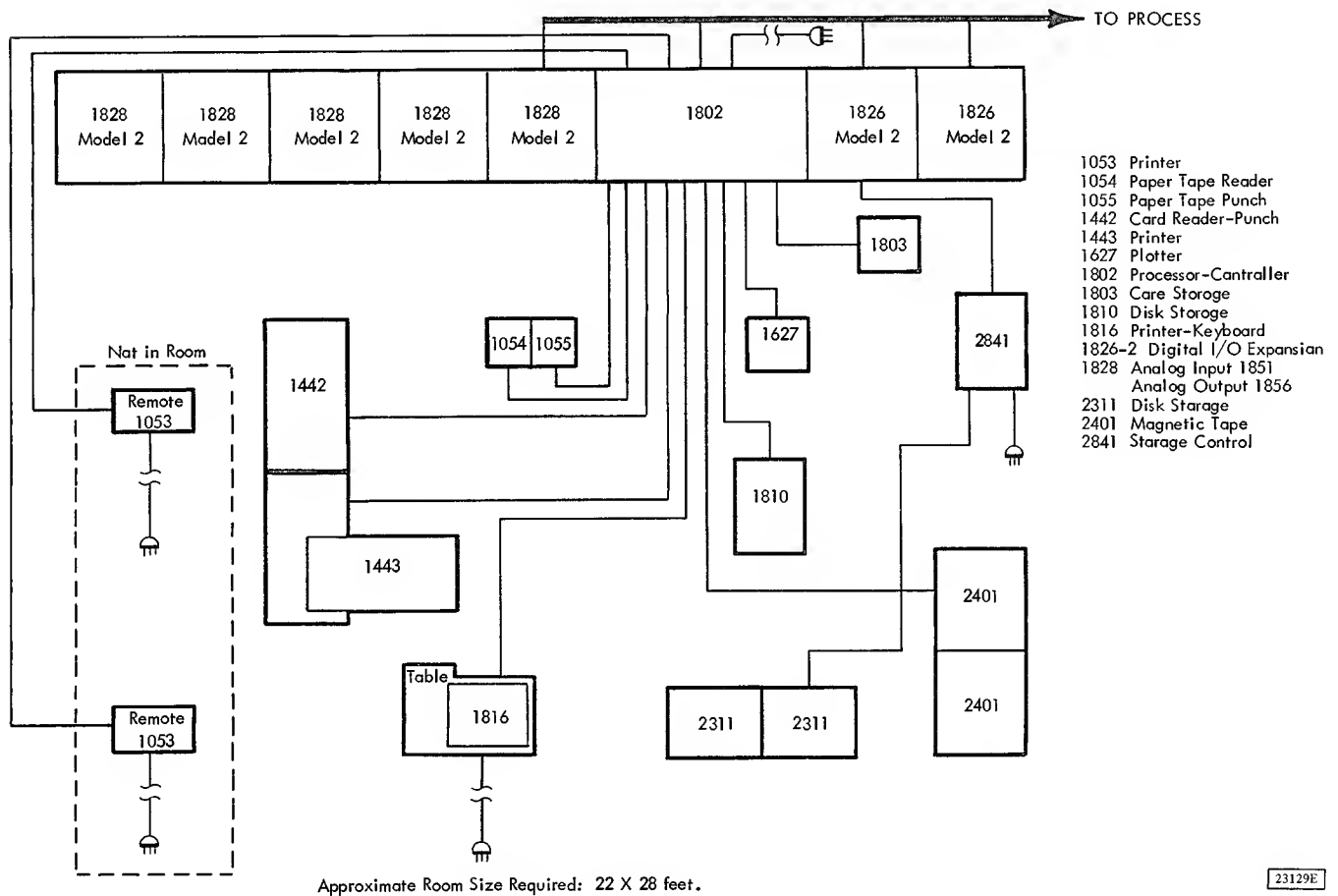
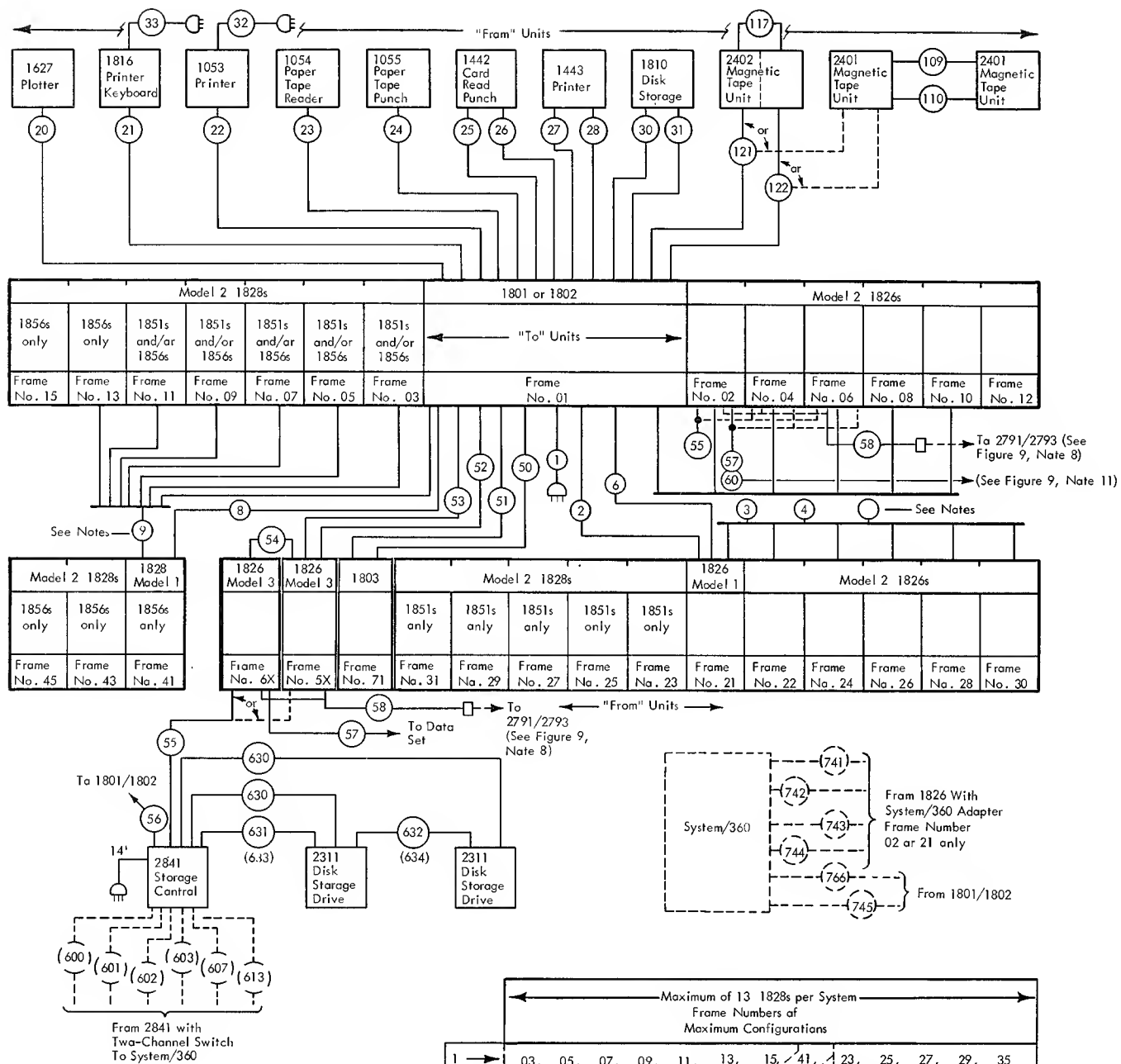


Figure 7. Sample Configuration (Large)



#### Notes:

Cable Groups (3), (4), (5), and (9) are individually ordered once per system.

Cable (9) (Analog Output) will always connect to frame number 41 (1828 Model 1) of the "FROM" units and will be routed to the highest numbered frame (in the "TO" units) that contains an 1856 (in 1828 Model 2 or frame 01 if no 1856 in "TO" units).

Cable group number (3) (Process Interrupt) or (4) (Digital Input), or (5) (Digital Output) will connect to the highest numbered "TO" frame that contains the feature and will be routed from the lowest numbered "FROM" frame that contains the respective feature. If the feature does not appear in the "TO" units the cable will connect to frame 01.

Cable groups 600-603, 607, 613, 741-745, and 766 are listed in Physical Planning System/360 Cable Order Form and Installation Manual — Physical Planning

Cable groups 630-634 are listed as part of 1800 System (see Figure 9)

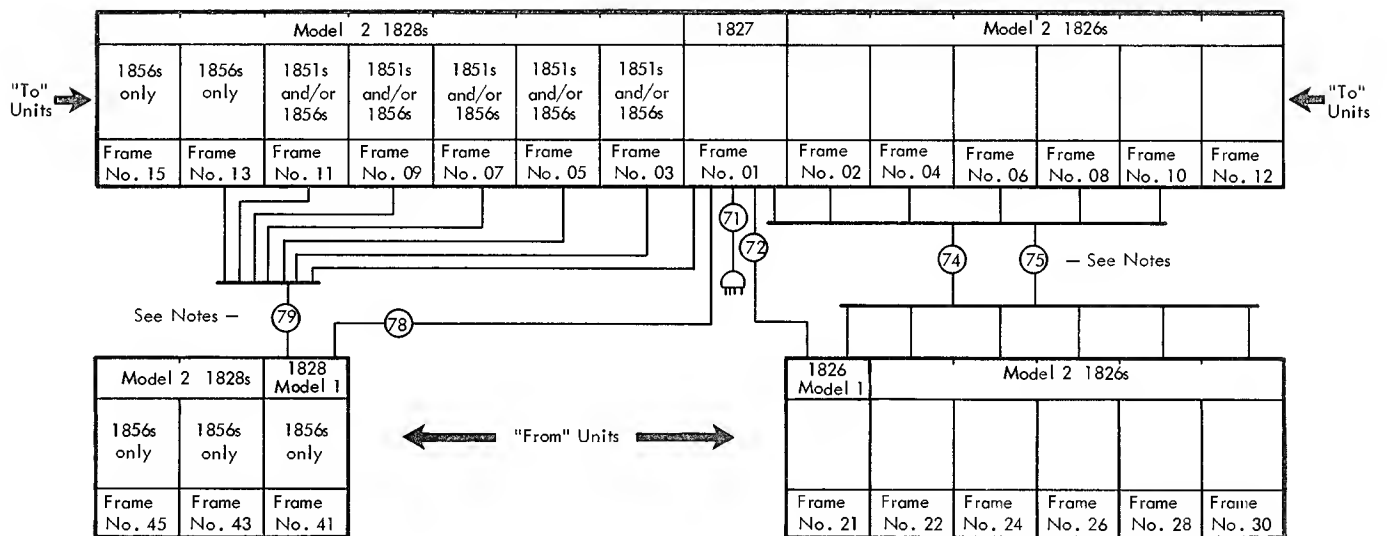
Maximum of 13 1828s per System	
Frame Numbers of Maximum Configurations	
1 →	03, 05, 07, 09, 11, 13, 15, 41, 23, 25, 27, 29, 35
2 →	03, 05, 07, 09, 11, 13, 41, 43, 23, 25, 27, 29, 35
3 →	03, 05, 07, 09, 11, 41, 43, 45, 23, 25, 27, 29, 35
	Model 2 Units Bolted to 1801 or 1802      Model 1 Units      Model 2 Units Bolted to Model 1      Model 2 Units Bolted to 1826 Model 1

Cable groups 52, 53, and 54 are ordered for 1826-3 features: 9311, 9312, and 9313 with following exceptions:

1. 9311 cannot be used if any model 1810 is configured. Frame number for first 1826-3 is 51, second 1826-3 is 61
2. 9312 cannot be used if 1826-1 with S/360 adapter or analog input expander is configured. Frame number for first 1826-3 is 52; second 1826-3 is 62.
3. 9313 is only applicable if configuration includes a data channel expander. Frame number for first 1826-3 is 53; second 1826-3 is 63

23176 1 J

Figure 8. 1800 System Cabling Schematic (Part 1 of 2)

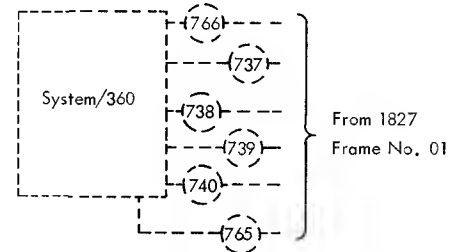


Notes: Cable Groups (74), (75), and (79) are individually ordered once per system.

Cable (79) (Analog Output) will always connect to frame number 41 (1828 Model 1) of the "FROM" units and will be routed to the highest numbered frame (in the "TO" units) that contains an 1856 (in 1828 Model 2 or frame 01 if no 1856 in "TO" units).

Cable group number (74) (Digital Input), or (75) (Digital Output) will connect to the Highest numbered "TO" frame that contains the feature and will be routed from the lowest numbered "FROM" frame that contains the respective feature. If the feature does not appear in the "TO" units the cable will connect to frame 01.

Cable groups 737 through 740, 765 and 766 are listed in IBM System/360 Installation Manual - Physical Planning, Order No. GC22-6820.



← Maximum of 8 1828s per 1827 → Frame Numbers of Maximum Configurations			
1 →	03, 05, 07, 09, 11, 13, 15, 41		
2 →	03, 05, 07, 09, 11, 13, 41, 43		
3 →	03, 05, 07, 09, 11, 41, 43, 45		
	Model 2 Units Bolted to 1827	Model 1 Units	Model 2 Units Abutted to Model 1

← Maximum of 6 1826s per 1827 → Frame Numbers of Maximum Configurations		Plus two 1826-3 per System
Model 2 1826s Abutted to 1827		
1 →	02, 04, 06, 08, 10, 12	5X, 6X
2 →	02, 04, 06, 08, 10, 21	5X, 6X
3 →	02, 04, 06, 08, 21, 22	5X, 6X
4 →	02, 04, 06, 21, 22, 24	5X, 6X
5 →	02, 04, 21, 22, 24, 26	5X, 6X
6 →	02, 21, 22, 24, 26, 28	5X, 6X
7 →	21, 22, 24, 26, 28, 30	5X, 6X
Model 1 1826	Model 2 1826s Bolted to Model 1 1826	

23176 2F

Figure 8. 1800 System Cabling Schematic (part 2 of 2)

1801 or 1802

Cable Group Number	Cable Qty	Standard Length <sup>1</sup>	Maximum X Length (Feet)	Cable Diameter (Inches)	Cable Bending Radius (Inches)	FROM	TO UNIT		Function	Feature Information	Notes
						Unit	Unit	Connector Code No. <sup>2</sup>			
1	1	14	14 (fixed)	1.500	7.5	Power Outlet	1801 or 1802	1	Power		
2	2	50	100	0.880	4.0	1826 Model 1	1801 or 1802	6	Power Control		
3	2	50	100	1.000	3.0	1826 Model 1	1801 or 1802	3	Signal, Process Interrupt	5710	1, 2
4	1	50	100	1.000	3.0	Frame #	Frame #	3	Signal, Process Interrupt		
5	1	50	100	1.000	3.0	Frame #	Frame #	3	Signal, Digital Input	3262 or 5861	1
6	2	50	100	1.000	3.0	Frame #	Frame #	3	Signal, Digital Output	3296	1
8	2	50	100	0.875	3.0	1828 Model 1	1801 or 1802	6	Signal, Analog Input Expander	1237 or 7720	
9	1	50	100	0.500	2.0	1828 Model 1	1801 or 1802	3	Signal, Analog Input Expander	(1 only)	
20	1	20	20	1.000	3.0	1828 Model 1	1801 or 1802	6	Power Control		
21	2	20	50	0.525	2.0	1627	1801 or 1802	3	Signal, Analog Out		1
22	1	20	50	0.600	2.0	1816 Pwr #1 or 2	1801 or 1802	5	Power and Signal		
23	1	20	50	0.475	2.0	1816 Kybd	1801 or 1802	3, 8	Signal		
24	1	8	2000	0.600	2.0	Each 1053	1801 or 1802	3, 7	Signal		
25	1	20	20	0.750	3.0	1054	1801 or 1802	3, 8	Signal		
26	1	20	20	0.405	2.0	1055	1801 or 1802	5	Power and Signal		
27	2	25	25	0.750	3.0	1442 1st or 2nd	1801 or 1802	6	Power and Signal		
28	1	25	25	1.090	3.0	1442 1st or 2nd	1801 or 1802	3 (2)	Power		
30	1	25	25	0.750	3.0	1443	1801 or 1802	5	Power Sequence		
31	2	20	20	0.560	2.0	1443	1801 or 1802	2	Power		
32	1	20	20	0.750	3.0	1443	1801 or 1802	3	Signal		
33	1	20	20	0.750	3.0	1810	1801 or 1802	6	Power		
34	2	20	20	1.000	3.0	1810	1801 or 1802	3	Signal		
35	1	8	8 (fixed)	1.000	3.0	1810	1801 or 1802	3	Signal		
36	1	8	8 (fixed)	0.400	2.0	Power Outlet	1053		Power		
37	1	8	8 (fixed)	0.400	2.0	Power Outlet	1816		Power		
38	1	16	16	0.880	4.0	1803	1801 or 1802		Power		
39	2	13	13	1.005	4.0	1803	1801 or 1802		Signal		
40	2	13	13	1.005	4.0	1803	1801 or 1802		Signal		
41	2	25	Note 5	1.000	3.0	1826 Model 3	1801 or 1802		Signal		
42	2	25	Note 5	1.000	3.0	1826 Model 3	1801 or 1802		Signal		
43	1	25	Note 5	0.880	4.0	1826 Model 3	1801 or 1802		Power		
44	3	5	Note 5	1.000	3.0	1826 Model 3	1826 Model 3		Signal		
45	3	5	Note 5	1.000	3.0	1826 Model 3	1826 Model 3		Signal		
46	3	5	Note 5	0.880	4.0	1826 Model 3	1826 Model 3		Power		
47	2	50	100	1.000	3.0	2841	1826 Model 2 or 3		Signal	7710 on 1826	3
48	1	50	100	1.000	3.0	2841	1826 Model 2 or 3		Signal		
49	1	50	100	0.500	2.0	2841	1801 or 1802		E.P.O.	7710 on 1826	
50	1	25	50	0.500	2.0	Data Set	1826 Model 2 or 3	12	Signal	7551 on 1826	11
51	1	40	40	0.750	3.0	Junction	1826 Model 2 or 3	13	Signal	7570 on 1826	8, 10
52	1	14	14 (fixed)	1.500	7.5	Power Outlet	2841	1	Power		
53	1	25	100	0.750	3.0	2401 or 2402	1802	4	Power		5
54	1	25	100	1.000	3.0	2401 or 2402	1802	3 (3)	Signal		3
55	1	5	Note 3	1.000	3.0	2nd 2401	1st 2401		Signal		3
56	1	5	Note 3	0.750	3.0	2nd 2401	1st 2401		Power		3
57	1	Fixed	Fixed	1.000	3.0	1/2 2402	1/2 2402	4	Jumper Signal Cable		
58	1	25	50	1.000	3.0	2311	2841	9	Power		
59	1	25	50	1.000	3.0	2311	2841	10	Power		7, 9
60	2	25	Note 6	1.000	3.0	2311	2841	11	Signal		
61	2	10	Note 6	1.000	3.0	2311	2311	10	Power		7
62	2	10	Note 6	1.000	3.0	2311	2311	11	Signal		

1827

71	1	14	14 (fixed)	1.500	7.5	Power Outlet	1827	1	Power		
72	2	50	100	0.880	4.0	1826 Model 1	1827	6	Power Control		
73	2	50	100	0.500	2.0	1826 Model 1	1827				
74	1	50	100	1.000	3.0	Frame #	Frame #	3	Signal, Digital Input	3262 or 5861	1
75	1	50	100	1.000	3.0	Frame #	Frame #	3	Signal, Digital Output	3296	1
76	2	50	100	0.875	3.0	1828 Model 1	1827	6	Power Control		
77	2	50	100	0.500	2.0	1828 Model 1	1827				
78	1	50	100	1.000	3.0	1828 Model 1	Frame #	3	Signal, Analog Out		1

<sup>1</sup> Connectors code numbers are identified for each connector illustrated in the System Cable Connector figure.

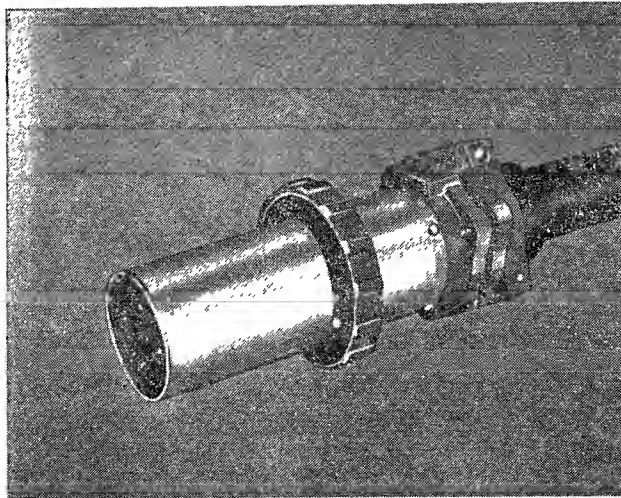
<sup>2</sup> Standard length cables will be shipped unless a cable order form is received 120 days prior to scheduled delivery

Notes

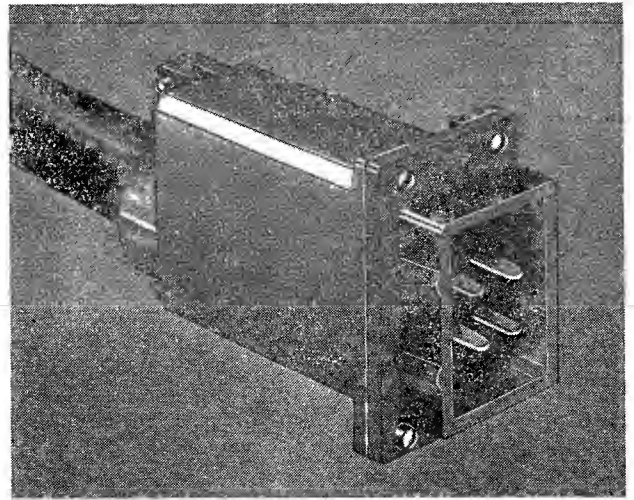
1. Frame number for cable routing ("FROM" unit - "TO" unit) can be determined from the information supplied in the System Cabling Schematic figure.
2. The second cable in Cable Group 3 will be routed to the same frame number as designated for the first cable of that group.
3. Total length of 100 feet available for sum of group 121 + group 110 or group 122 + group 109 when two 2401s are used
4. Where the "TO" unit is 1801 or 1802 all Code 3 connectors use cable entry point B, all other connectors use cable entry A.
5. Maximum X length of group 52 plus 54 is 40 ft. maximum X length of group 53 plus 54 is 60 ft.
6. Maximum X length of group 631 plus 632 is 100 ft
7. Cable group numbers in ( ) are ordered for 50 Hz systems.
8. Cable 58 is terminated with four IBM-provided type 283B plugs. The mating connectors are customer-provided Western Electric type 404B surface mounted or Western Electric type 493A flush mounted or equivalent jacks. See 2790 Physical Planning, Order No. GA27-3017
9. Cable group 631 (633) includes end-of-line terminator.
10. Order one cable group 58 for each 7570 feature installed. Maximum: two per system.
11. Order group 60 for use with GPO Data 1 Model 5 or equivalent data set; order group 57 for use with all other data sets.

231780

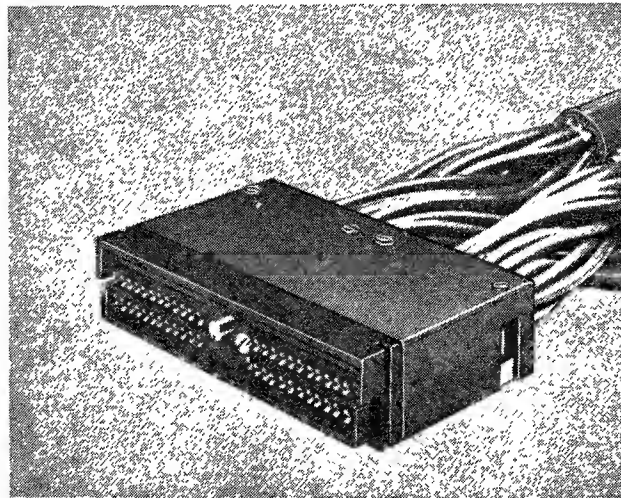
Figure 9. 1800 System Cabling Specifications



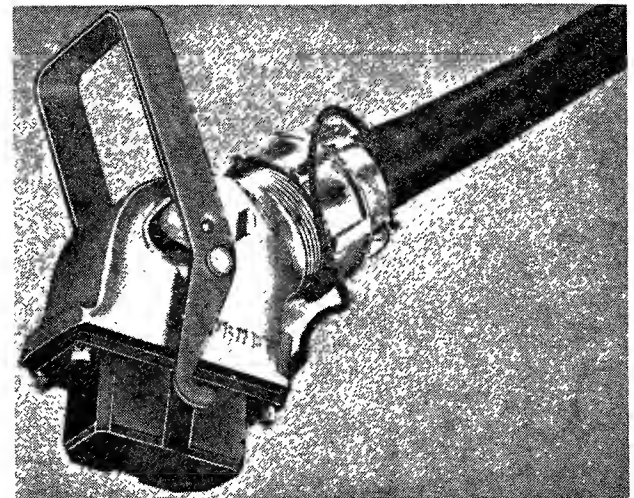
Power Cord Connector (3-phase, 60-amp, O.D. 3.75 inches, 9 inches long) Code 1



Power Connector (1.7 inches high, 1.42 inches wide, 3.28 inches deep) Code 2



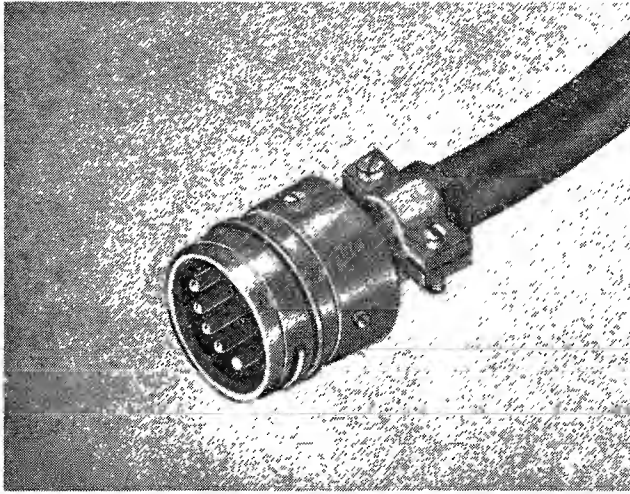
1800 System Interface Connector (3 inches high, 4 inches wide, 1 inch deep) Code 3



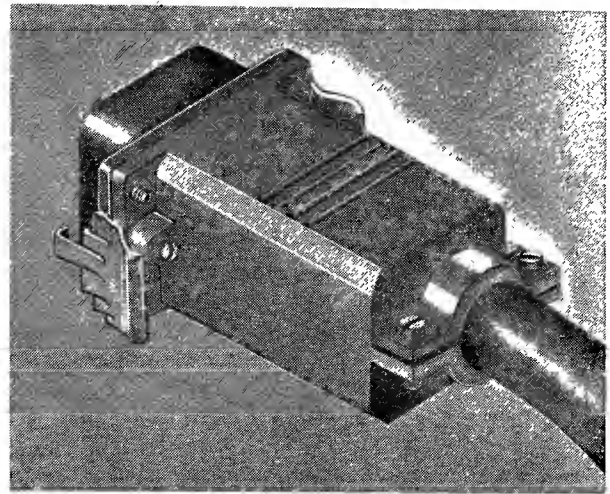
Tape Power Cable Connector (3.62 inches high, 4.5 inches deep, 2.06 inches wide) Code 4

30124.0

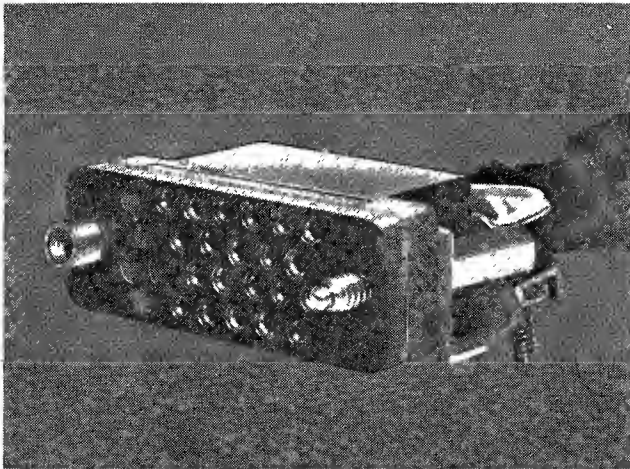
Figure 10. 1800 System Cable Connectors (part 1 of 3)



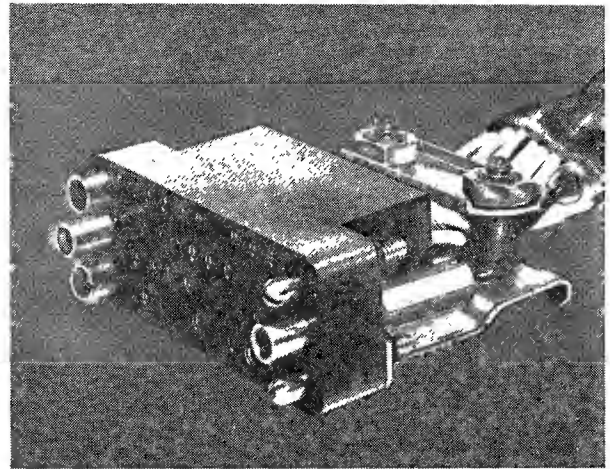
Power and Signal Connector  
(1.5 inches diameter, 1.2 inches long) Code 5



Power Connector (1.6 inches high, 1.5 inches  
wide, 4 inches deep) Code 6



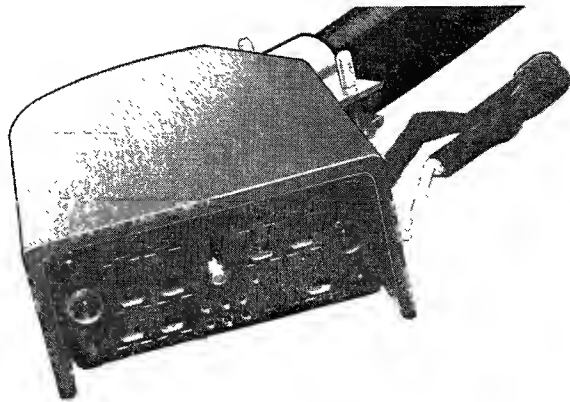
1816 Signal Connector  
(0.62 inches high, 1.62 inches wide,  
1.00 inch deep) Code 7



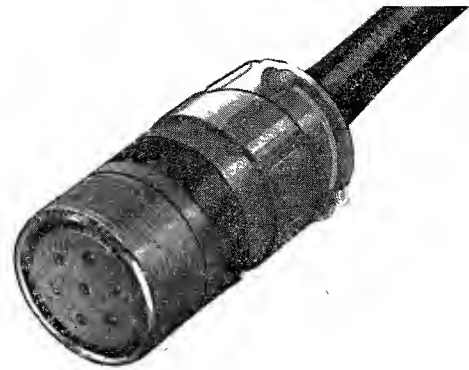
1053 Signal Connector  
(0.75 inches high, 2.00 inches wide,  
1.00 inch deep) Code 8

30124.1

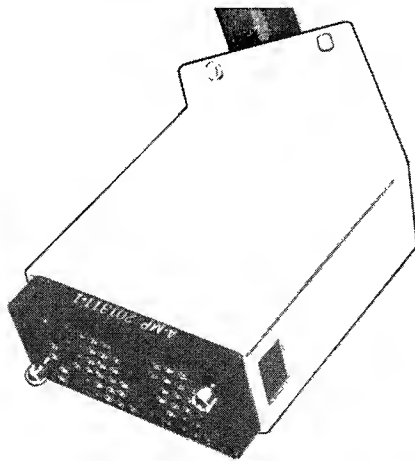
Figure 10. 1800 System Cable Connectors (part 2 of 3)



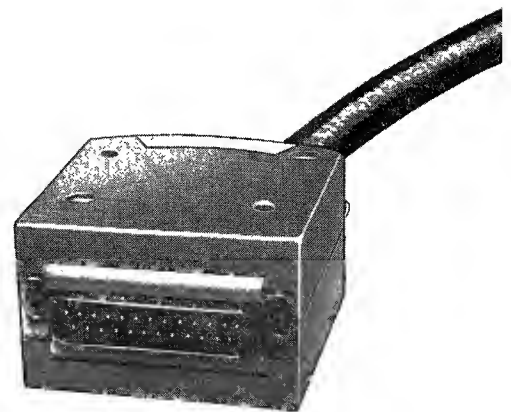
2311 DC Connector (1.5 inches high, 2.7 inches wide, 4 inches deep) Code 9



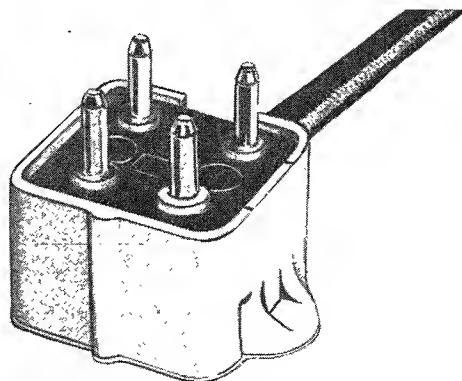
2311 AC Connector (1.5 inches diameter, 3.25 inches long) Code 10



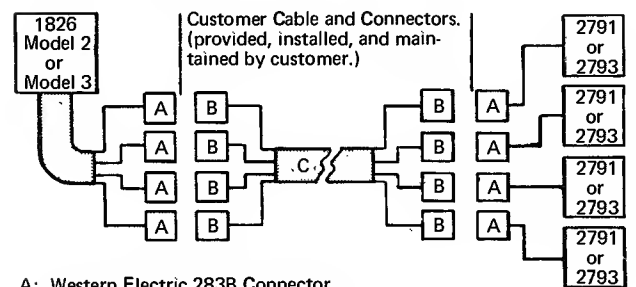
2311 Signal Connector (1.25 inches high, 2.75 inches wide, 5 inches deep) Code 11



Data Set Signal Connector (1.38 inches high, 2.19 inches wide, 2.62 inches deep) Code 12



2790 Signal Connector (1.32 inches high, 1.80 inches wide, 0.90 inches deep) Code 13



30124.2 B

Figure 10. 1800 System Cable Connectors (part 3 of 3)



## SECTION 2 IBM 1800 SYSTEM BASIC UNITS

### IBM 1801 AND 1802 PROCESSOR-CONTROLLERS

The 1801 and 1802 Processor-Controllers are available in several models, depending upon the core storage capacity and cycle time desired. Five core storage sizes are available in the 1801 or 1802 --- 4096; 8192; 16,384; 24,576; 32,768 words -- with storage cycle times of 2 or 4 microseconds (2.25 microseconds with the additional storage feature).

Additional storage is available in the 1803 core storage unit in increments of 8192 words, with a combined system maximum of 65,536 words. With the additional storage feature, the 1801 or 1802 contains 24,576 words, and the additional 16,384 to 40,960 words are located in the 1803.

In addition to the many special features available, the standard features include: three data channels, three index registers, three interval timers, 12 levels of interrupt, operations monitor, storage protection, power failure protection, parity, double precision arithmetic, multiply-divide, and an operator's console. The IBM 1802 provides magnetic tape control in addition to the above mentioned features. Descriptions of the standard features which affect installation physical planning follow.

### DATA CHANNELS

Three standard data channels provide high speed operating channels which permit overlapped operation of system units or features. 12 additional data channels are available. The user may assign priority of operation. Standard assignments are made at order entry time. The user may change these assignments via a change order.

### INTERRUPT

Twelve levels of interrupt are standard in the 1801 or 1802. Twelve additional levels are available in groups of six. Sixteen separate interrupts can be assigned to each level. These interrupts are generated by programmed instruction; the data processing I/O units, process I/O units and features, and the attachment circuitry. The customer can assign all interrupts to any priority level, thus determining the priority of interrupts of the I/O device on the system. Interrupt levels are wired by IBM according to the information supplied on the Interrupt Level Assignment Form.

### Operations Monitor

The operations monitor is a device which causes a contact to close upon completion of a preset timeout period (selectable between 5 and 30 seconds  $\pm 10\%$ ), or in event of an 1801/1802 power failure. It notifies the process operator when the processor-controller is not executing a predetermined sequence of instructions. The customer is to furnish the alarm device and its power. Power is limited to 30 volts (ac or dc) and 1 ampere maximum. Two wire terminations (external "sync" terminals 14 and 15), using number 8 barrier type terminals, are provided in a customer accessible location in the machine.

### PROCESS I/O

The process I/O is divided into four general categories: analog input, digital input, digital output, and analog output.

#### Analog Input

The following features associated with analog input are installed in the 1801 or 1802. Customer terminations for analog input are made to the 1851 terminals mounted in 1828 enclosures.

Analog-Digital Converter, Mod 1. This feature converts analog signals to digital values with the following characteristics:

Input Type	Voltage, bipolar
Input Level	0 to $\pm 5$ volts
Input Impedance	10 megohms or greater
Output Value	8, 11 or 14 bits plus sign
Conversion Time	29, 36 or 44 microseconds
ADC Rate	up to 11K conversions per second (maximum possible)

The number of output bits is program selected. In operation, the Mod 1 ADC will provide conversion rates up to 11,000 per second. This rate is possible only with certain system configurations and programming methods, and should not be considered as a sustained system conversion rate. See IBM 1800 Functional Characteristics, Order No. GA26-5918 for further details. The ADC includes a buffer amplifier.

Conversions can be synchronized from an external signal. After a point is addressed, a "ready" condition is transmitted to an external customer device; this device provides a "sync" pulse which either starts



conversion for relay points or starts multiplexing for solid state points. Sync and ready signal termination are in the 1801, 1802, 1826 with AI Expander, or 1827.

Analog-to-Digital Converter, Mod 2. This feature converts analog signals to digital values with the following characteristics:

Input Type	Voltage, bipolar
Input Level	0 to $\pm 5$ volts
Input Impedance	100K ohms
Output Value	8, 11, or 14 bits plus sign
Conversion Time	29, 36, or 44 microseconds
ADC Rate	up to 24K conversions per second (maximum possible)

The program selects the number of output bits. In operation, the Mod 2 ADC will provide conversion rates up to 24,000 per second. This rate is possible only with certain system configurations and programming methods, and should not be considered as a sustained system conversion rate. See IBM 1800 Functional Characteristics, Order No. GA26-5918, for further details. The ADC includes a sample and hold amplifier and can be synchronized from an external signal.

After a point is addressed, a "ready" condition is transmitted to an external customer device. This device provides a "sync" pulse which starts conversion for relay points or starts multiplexing for solid state points.

Comparator: This feature performs automatic range checking on digital values developed by the Analog-Digital Converter Mod 1 or Mod 2. High and low limits are obtained from the processor-controller core storage via the data channel that transmits their addresses for the analog input operation (random mode only). An out-of-limits condition alerts the processor-controller with an interrupt that permits the address of that input signal to be obtained under direct program control.

Multiplexer Overlap: Provides for overlap (simultaneous selection) of multiplexer/R (relay) and multiplexer/S (solid state) analog input multiplexer points which allows high speed scanning and conversion of the multiplexer/S points to occur while the slower multiplexer/R points are being selected.

Multiplexer/R Control: This feature provides the necessary circuitry to operate up to 16 multiplexer/R groups.

Multiplexer/S Control: Multiplexer/S control pro-

vides circuitry to operate up to 16 multiplexer/S high level single ended groups.

### Digital Input

The following digital input features may be installed in the 1801 or 1826. The number of each of the following available in an 1801 is dependent on the particular combination of features ordered and/or the termination capacity. When an 1802 is used on a system these features are located exclusively in the 1826. Customer terminals in the 1801 are illustrated in Figures 12 and 13.

Digital Input - Contact: Each group provides the status sensing circuitry and the terminals for up to 16 customer isolated, dry contacts.

Digital Input - Voltage: Each group provides terminals for the customer and the circuits for sensing the status of up to 16 customer voltage levels. A high speed option with unfiltered inputs allows switching rates up to 100 kc.

Pulse Counter (8-bit or 16-bit): Each pulse counter group provides an 8-bit or 16-bit capacity counter for counting pulse inputs.

### External Synchronization

Digital input and pulse counter reading can be synchronized from an external signal. Digital input addressing can generate a "ready" signal which is transmitted to an external customer device. This device provides a "sync" pulse which initiates entry of digital input data into the processor-controller. Synchronization terminals are located in the 1801, 1802, or 1827.

Process Interrupt - Contact: Each group provides terminals for the customer and the latching circuits for sensing and interrupting when a change occurs in the status of up to 16 customer isolated, dry contacts.

Process Interrupt - Voltage: Each group provides the customer with terminals and the latching circuits for sensing and interrupting when a change occurs in the status of up to 16 voltage level inputs.

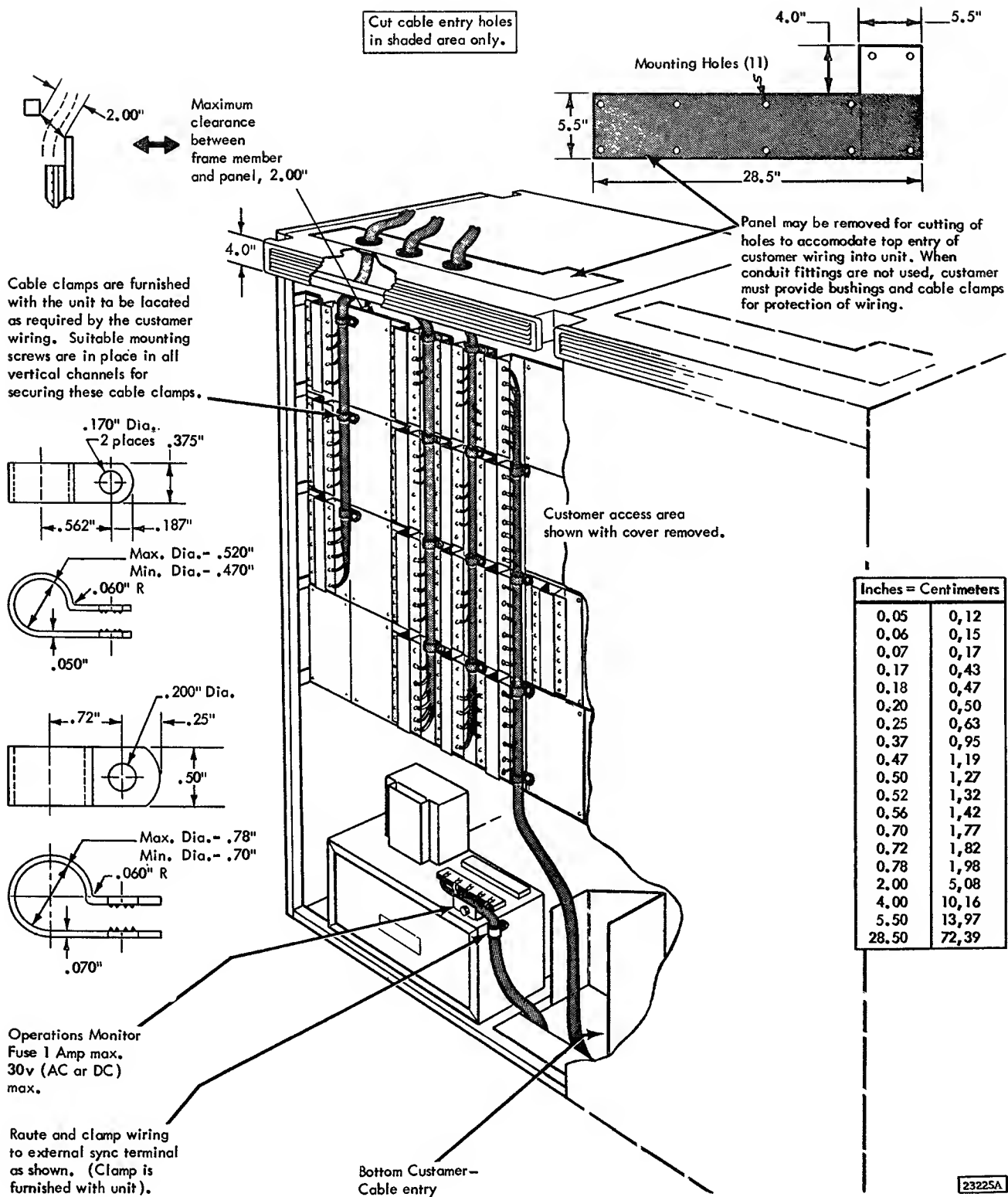
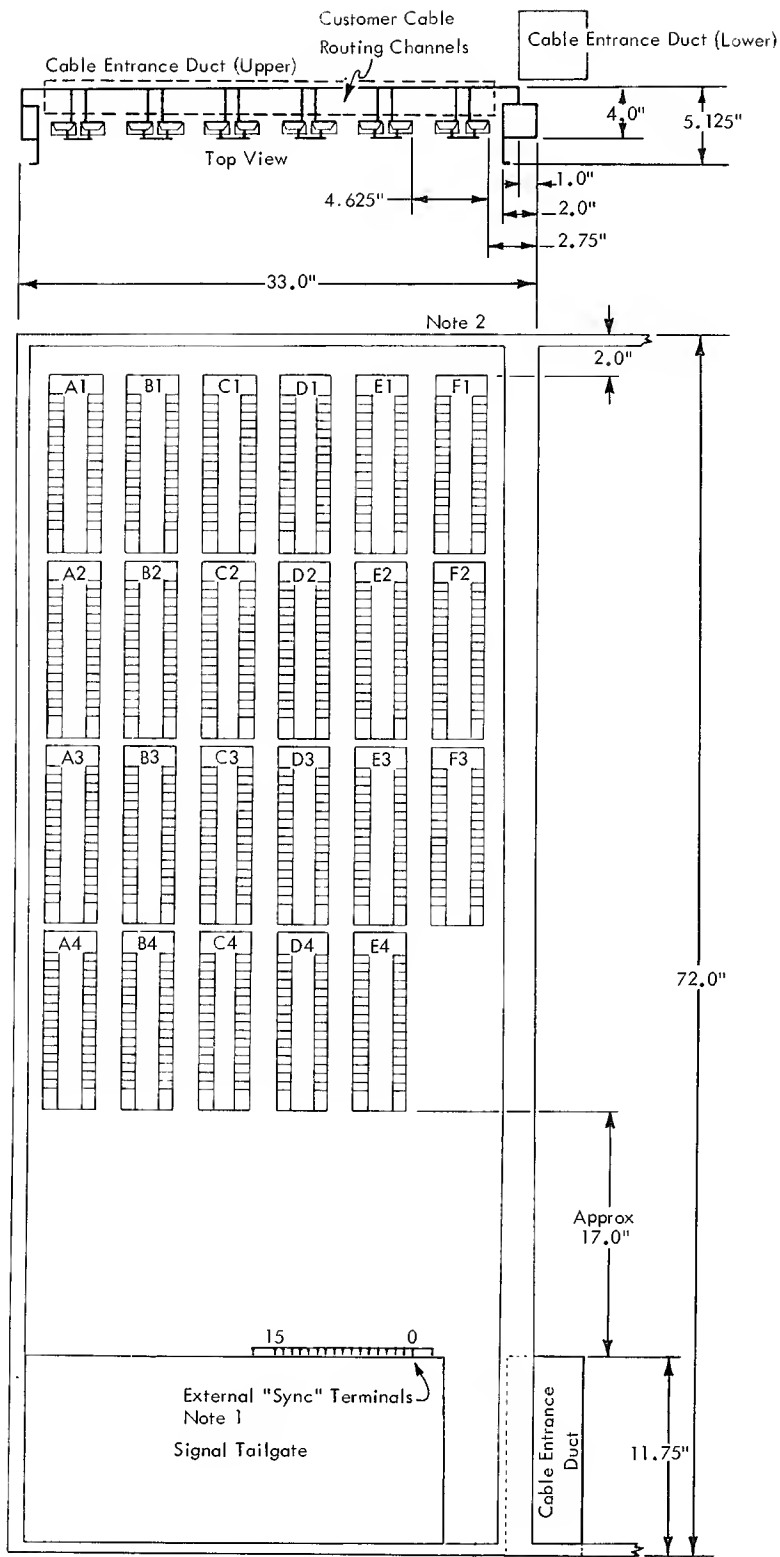


Figure 11. 1801 Customer Cabling Routing



Inches = Centimeters	
1.00	2,5
2.00	5,0
2.75	6,9
4.00	10,1
4.62	11,6
5.00	12,7
5.12	12,9
11.75	29,8
17.00	43,1
33.00	83,8
72.00	182,8

#### Sync Terminal Label

0	AI Rdy
1	DC Comm
2	AI Sync
3	DC Comm
4	DI Rdy
5	DC Comm
6	DI Sync
7	DC Comm
8	DAO Rdy
9	DC Comm
10	DAO Sync
11	DC Comm
12	Test Out
13	DC Comm
14	OP Mon
15	OP Mon

#### Notes:

1. An additional terminal strip is provided next to the sync terminals for spares.
2. Cable entry hole is 4" above frame.

23134D

Figure 12. 1801 Customer Terminations

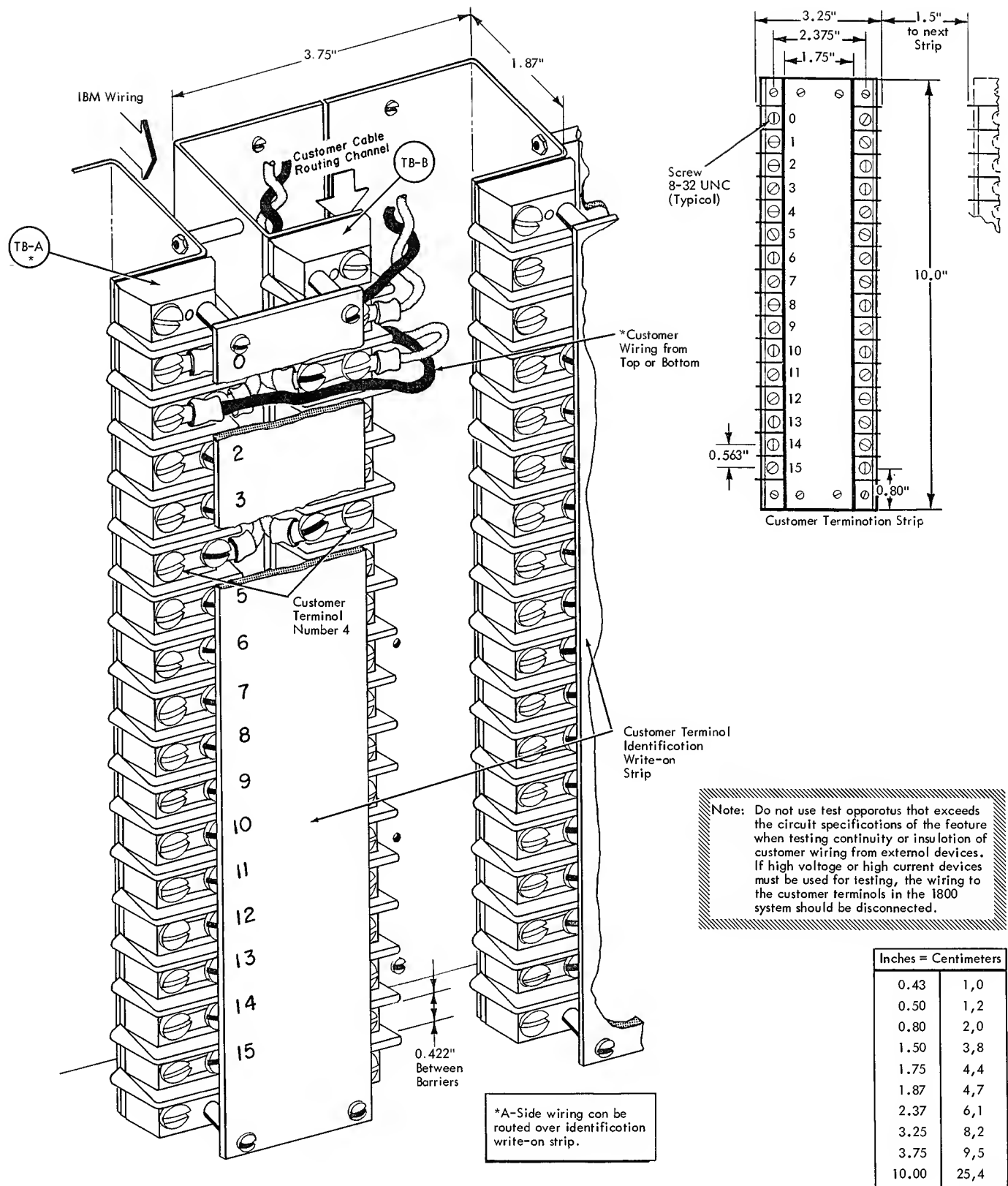


Figure 13. Customer Wiring to 1801, 1826, and 1827 Terminals

## Digital Output

The following digital output features may be installed in either the 1801 or the 1826. The number of groups of each that are available for the 1801 is dependent on the particular combination of features ordered and/or the termination capacity. When an 1802 is used on a system these features are located exclusively in the 1826. Customer terminals in the 1801 are illustrated in Figures 12 and 13.

Electronic "Contact" Operate: Each group provides terminals for the customer and circuits for the electronic switching and latching of 16 customer lines carrying customer-supplied power up to 48 vdc at 0.45 amps.

Pulse Output: Each group provides terminals and circuits for momentary electronic switching of 16 customer lines, each carrying customer-supplied power up to 48 vdc at 0.45 amps with a duration of 3 milliseconds.

Register Output: Each register output group provides terminals and the circuitry for transmitting 16-bit words of binary data at repetitive speeds up to 500,000 words per second to customer registers. Voltage outputs are +3 volts for binary 1 and 0 volts for binary 0.

## Analog Output

The 1801 or 1802 can provide the adaptation circuitry and cabling attachment for analog output features which are housed in 1856 terminals mounted in 1828 enclosures.

## External Synchronization

A digital or analog output function can be synchronized from an external signal. Addressing of DAO can generate a "ready" signal which is transmitted to an external customer device. This device generates a "sync" pulse which initiates the output function. Termination is in the 1801, 1802, or 1827.

## DATA PROCESSING INPUT/OUTPUT

The following DP I/O units can be attached to the 1801 or 1802:

- 2 - 1816 Printer-KeyBoard
- 8 - 1053 Output Printer (6 with 2 - 1816s installed)

- 1 - 1054 Paper Tape Reader
- 1 - 1055 Paper Tape Punch
- 2 - 1442 Card Read-Punch, Model 6 or 7  
(1 - 1442 if 1054 or 1055 or Data Channel Expander in system)
- 1 - 1627 Plotter, Model 1 or 2
- 1 - 1443 Printer, Model 1 or 2
- 1 - 1810 Disk Storage, Model A1, A2, A3, B1, B2, or B3
- 8 - 2311 Disk Storage Drives with one 2841 Storage Control
- 4 - Communication Adapters  
(2 Line Adapters per CA)
- 2 - 2790 Adapters

In addition, the 1802 will accommodate either:

- 1 or 2 - 2401 Magnetic Tape Units, Model 1, 2, or 3
- or 1 - 2402 Magnetic Tape Unit, Model 1, 2 or 3

## IBM 1803 Core Storage Unit

The IBM 1803 Core Storage Unit is a free standing unit designed to allow for expansion of core storage size above the 32,768 words available in the 1801 or 1802 processor-controller. With the additional storage feature, 24,576 core storage words are contained in the 1801 or 1802 with the additional storage in the 1803. The 1803 is available with 16,384 to 40,960 core storage words, in increments of 8192 words, for a maximum system core storage capacity of 65,536 words.

## IBM 1826 DATA ADAPTER UNIT

The IBM 1826 Data Adapter Unit is designed to permit the expansion of digital input and digital output features on the 1800 system. The 1826 is available in three models.

The model 1 is a free-standing unit which is externally cabled to and may be located as much as 100 feet from the 1801, 1802 or 1827 units. One 1826 model 1 may be used with the 1801, 1802, or 1827.

The 1826 model 2 is directly attached (to the right) of the 1801, 1802, 1826 model 1 or 1827. Cabling to or from the model 2 may be internal between attached units or external to a series of units not attached. Specific information on cable routing can be found in the cabling schematic (Figure 8). The maximum number of model 2s that may be used is dependent upon the configuration and requirements of the user.

### Analog Input Expander

The Analog Input Expander is for use in the 1826 model 1 only. The feature permits the attachment of the following analog input features: Analog-Digital Converter Model 1, Analog-Digital Converter Mod 2, Comparator, Multiplexer Overlap, Multiplexer/R Control and Multiplexer/R Control Additional, and Multiplexer/S Control. Description of these features can be found in the subparagraphs of "IBM 1801 and 1802 Processor-Controllers" in this manual.

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The 1826 model 3 is a free-standing unit, which does not contain any customer terminations. The model 3 is used to house the selector channel, communications adapter and 2790 adapter.

The 1826 does not provide analog output capability. Under various conditions, up to 576 process terminations of the following features may be installed on the 1826: Process Interrupt - Contact, Process Interrupt - Voltage, Digital Input - Contact, Digital Input - Voltage, Pulse Counter, Electronic "Contact" Operate, Pulse Output, System/360 adapter, and Register Output. Descriptions of these features (excluding System/360 adapter) are the same as described for the 1801. Figure 15 illustrates the customer terminal area of the 1826. See Figure 13 for details of the individual terminal block.

#### System/360 Adapter

The System/360 adapter is for use in the 1826 model 1 or 2. This feature permits communication between the 1800 P-C and the System/360. Each system regards the other as an I/O device capable of requesting service on a random basis. The System/360 adapter is functionally equivalent to the corresponding System/360 channel-to-channel adapter.

#### Selector Channel

The selector channel provides a means for attaching a 2841 control unit with up to eight 2311's to the 1800 process controller. The 2841 is connected to logical position one of the selector channel and has the two-channel switch feature as an option. The selector channel is available in the 1826 model 2 or 3, on 2 or 2.25 microsecond systems.

#### Communications Adapter

The communications adapter (CA) feature permits the 1800 system to communicate with other systems which have the appropriate communication attachment. The communication facilities may be private or leased voice grade lines, or switched telephone networks, and either two or four-wire connection.

In dial-up network operation, the CA will automatically answer calls originated by a remote station (auto-answer function). The data-link may operate full duplex, thus reducing line turn-around delays, but message transmission will be half-duplex only (transmission in one direction at a time).

#### 2790 Adapter\*

The 2790 adapter provides the capability to attach a maximum of 100 IBM 2791/2793 Area Stations. In

addition, a maximum of 1,024 IBM data entry devices (IBM 2795/2796 Data Entry Units or customer-provided digital devices) may be attached via interfaces in the area stations. The adapter interfaces to the 1801/1802 via a data channel.

The 2791/2793 Area Stations provide operations on the manufacturing floor with the capability of transmitting data to, and receiving data from, the 1800. Data read from cards or badges, or entered by a numeric keyboard or customer-provided digital devices, can be transmitted to the 1800 either by or via the area station.

2791 Area Station: The 2791 Area Station is either a table or shelf mounted unit that comes in two models. The model 1 is a combination input station and controller for the 1035 Badge Reader, 2795/2796/2797 Data Entry Units and the 1053 Printer. The model 1 can have up to 32 data entry devices, three 1035's and/or one 1053 attached. The model 2 is an input station only.

2793 Area Station: The 2793 Area Station is designed to service eight data entry devices as standard. Additional units can be attached on a feature basis to include up to 63 pulse counters, 24 additional data entry units, and one 1053 Printer.

2795 Data Entry Unit: The 2795 Data Entry Unit provides two 10-position switches, a 10-column numeric badge/card reader, and a phone jack in a single compact unit. The 2795 can be mounted on a bench, table, or wall. The phone jack permits the user to wire a voice communications system (customer facility) for use between DEU's and the control center.

2796 Data Entry Unit: The 2796 Data Entry Unit provides all functions of the 2795 plus six positions of manual entry and a monitor key. The six positions are for variable data entry.

The monitor key allows supervisory personnel to approve a given entry, which is done by releasing a locked key.

2797 Data Entry Unit: The 2797 Data Entry Unit provides all functions of the 2795 plus ten numeric keys for selecting up to six digits per data entry. A six-position visual display is provided to indicate the selection made by the ten keys. A monitor key and phone jack are also included.

The monitor key allows supervisory personnel to approve a given transaction. Approval is accomplished by transmitting a unique character by using a key in a lock device.

\* See IBM 2790 Data Communications System: Installation Manual - Physical Planning, Form A27-3017.



## IBM 1827 DATA CONTROL UNIT

The 1827 permits the use of many system features with the System/360. The 1800 features give the System/360 input and output capabilities that are applicable to a wide range of data acquisition and process control requirements. Under various conditions up to 288 process terminations of the following 1800 system features are available to the System/360 via the 1827: Digital Input - Contact, Digital Input - Voltage, Pulse Counter, Electronic "Contact" Operate, Pulse Output, and Register Output. The system features can be expanded through use of the IBM 1826. The 1800 system analog features available for the 1827 are: For Analog Inputs - Multiplexer/R Controls (for 1851s in 1828), Multiplexer/S Controls (for 1851s in 1828), Analog - Digital Converter Model 1 or 2, and Comparator; and Analog - Output (for 1856s in 1828).

Descriptions and the functional characteristics of the 1827 features are the same as for the 1801. Scanning speeds and command responses are subject to the restrictions of the System/360 Channel.

Figure 16 illustrates the customer terminal area within the 1827. See Figure 13 for details of the individual terminal block.

## IBM 1828 ENCLOSURE

The 1828 is used as an enclosure for the 1851 and 1856 terminals used with an 1800 system. The 1828 is available in two models.

### IBM 1828 Enclosure, Model 1

The model 1 is a free-standing enclosure that is externally cabled (maximum of 100 feet) to the 1801, 1802, or 1827 and will house up to six 1856 terminals. Maximum per system: 1 - 1828 model 1.

### IBM 1828 Enclosure, Model 2

The model 2 is a bolt-on (to the left) enclosure internally cabled to 1801, 1802, 1826 model 1, 1827, or other 1828s. It provides housing for combinations of 1851s and 1856s. Maximum per enclosure: six 1851s or 1856s in any combination. The number of model 2 enclosures required is dependent on the quantity of 1851 and 1856 terminals ordered.

The 1851 and 1856 are described in detail in the "Process I/O" section of this manual.

## ANALOG INPUT AND ANALOG OUTPUT TERMINATION REQUIREMENTS

Analog input and analog output are terminated in modular units installed in 1828 enclosures. Analog input is terminated in 1851 Multiplexer Terminals. See Section 4 of this manual for a complete description of these terminals. Analog Output Features are housed in 1856 Analog Output Terminals. See Section 4 of this manual for a complete description of Analog Output Terminals and Features. Figure 18 illustrates typical customer wiring within the 1828 enclosure. The IBM 1800 Data Acquisition and Control System Configurator describes the maximum quantities available on a system.

The placement of analog terminals in an 1828 enclosure and their computer address is determined by IBM at the plant of manufacture. Analog input termination is always located in 1828 model 2 enclosures abutted to an 1801 or 1802; or, in the case of AI Expander, abutted to an 1826 model 1. They are always installed sequentially from the top down and should always be in the 1828 model 2 closest to the 1801/1802 model 1. Thus, 1851 terminals are always given preference over 1856 terminals. The 1856 Analog Output terminals may occupy remaining positions in the 1828 model 2, and are installed sequentially from the bottom. Analog output terminals may not be installed in the 1828 model 2 abutted to an 1826 model 1, but can be installed remote from the 1801/1802 by ordering an 1828 model 1 and abutting 1828 model 2 for expansion. All 1851s must be located within the first five model 2 1828s to the left of the 1801/1802, 1826 model 1, or 1827. The maximum number of 1851s per ADC is 19. The six locations within the 1828 are shown in Figure 18.

IBM will install the 1851s and 1856s in the following order:

In 1828s from top to bottom - all multiplexer/S, followed by all multiplexer/R high level, followed by all multiplexer/R low level (lowest range first, highest range last).

In 1828s beginning at the bottom - alternate model 1 and model 2 1856s.

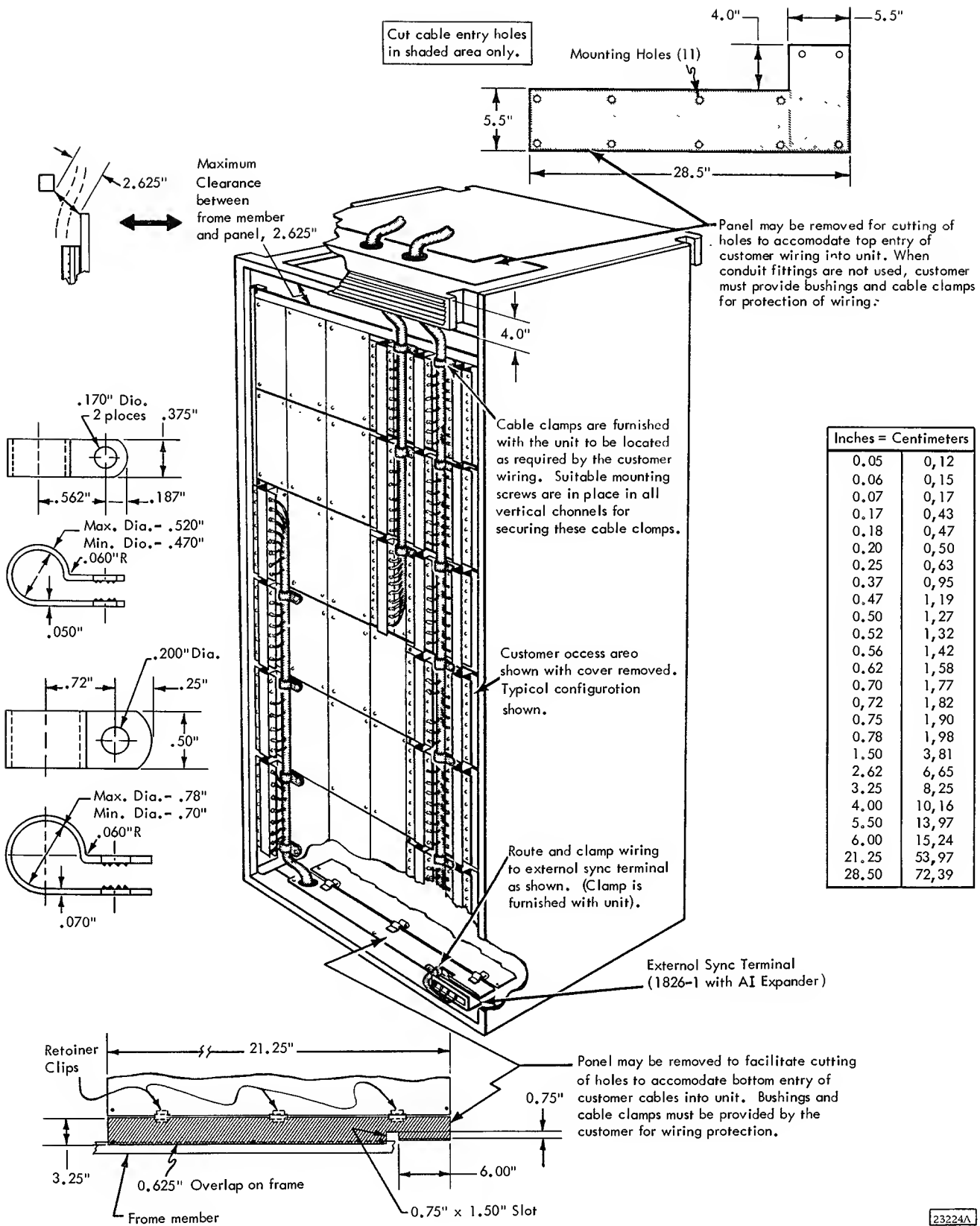


Figure 14. 1826 Customer Cable Routing

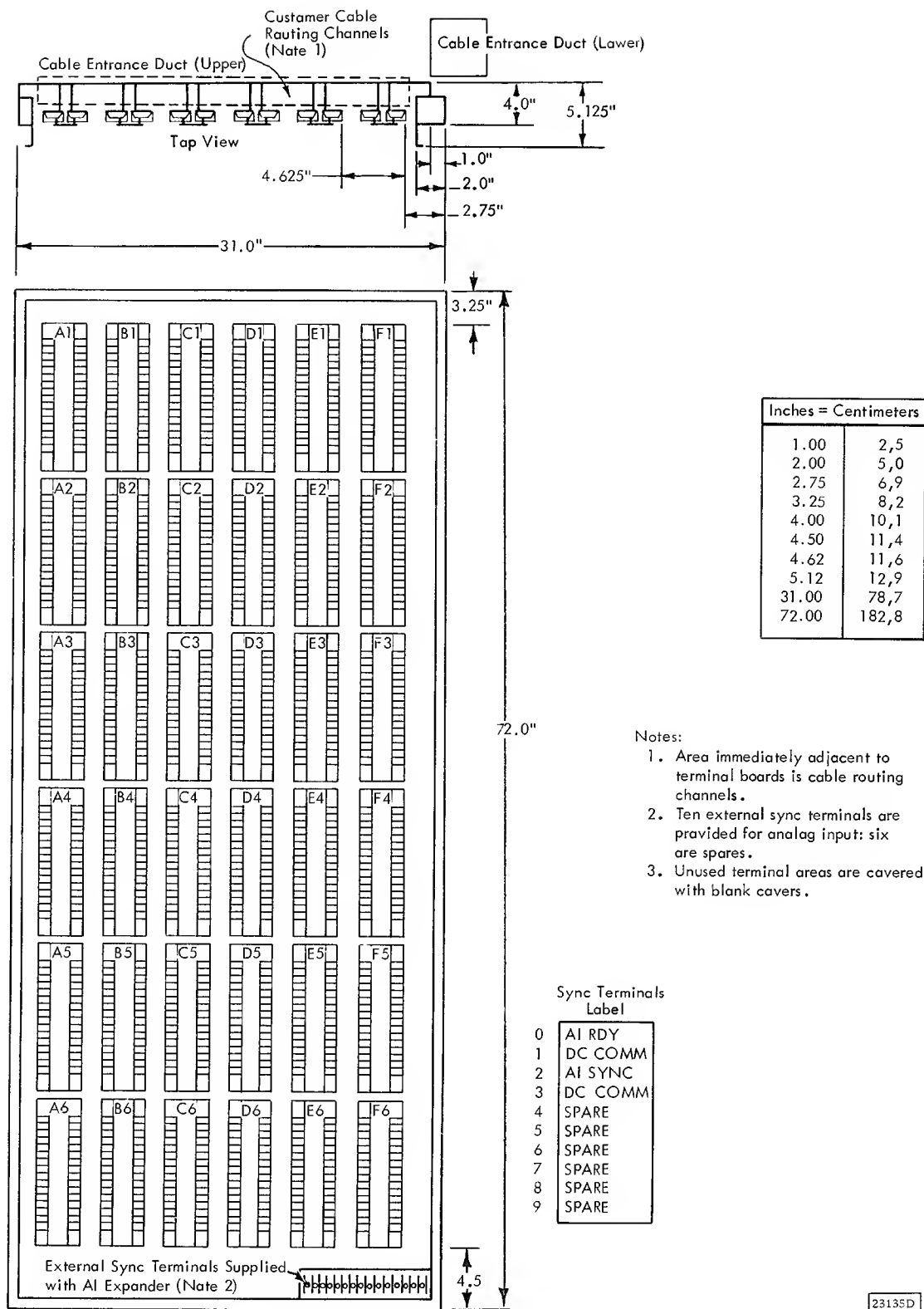


Figure 15. 1826 Customer Terminations

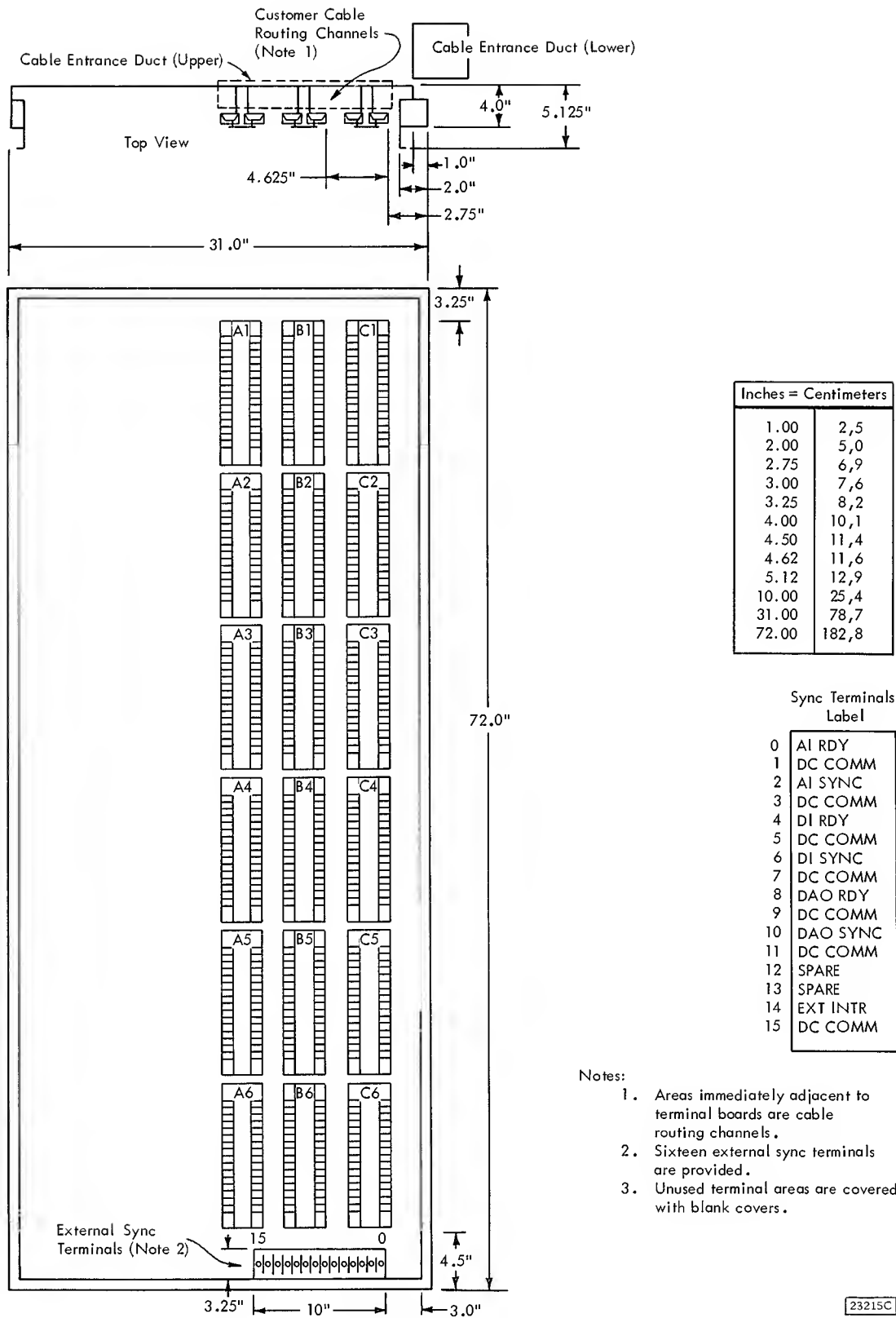


Figure 16. 1827 Customer Terminations

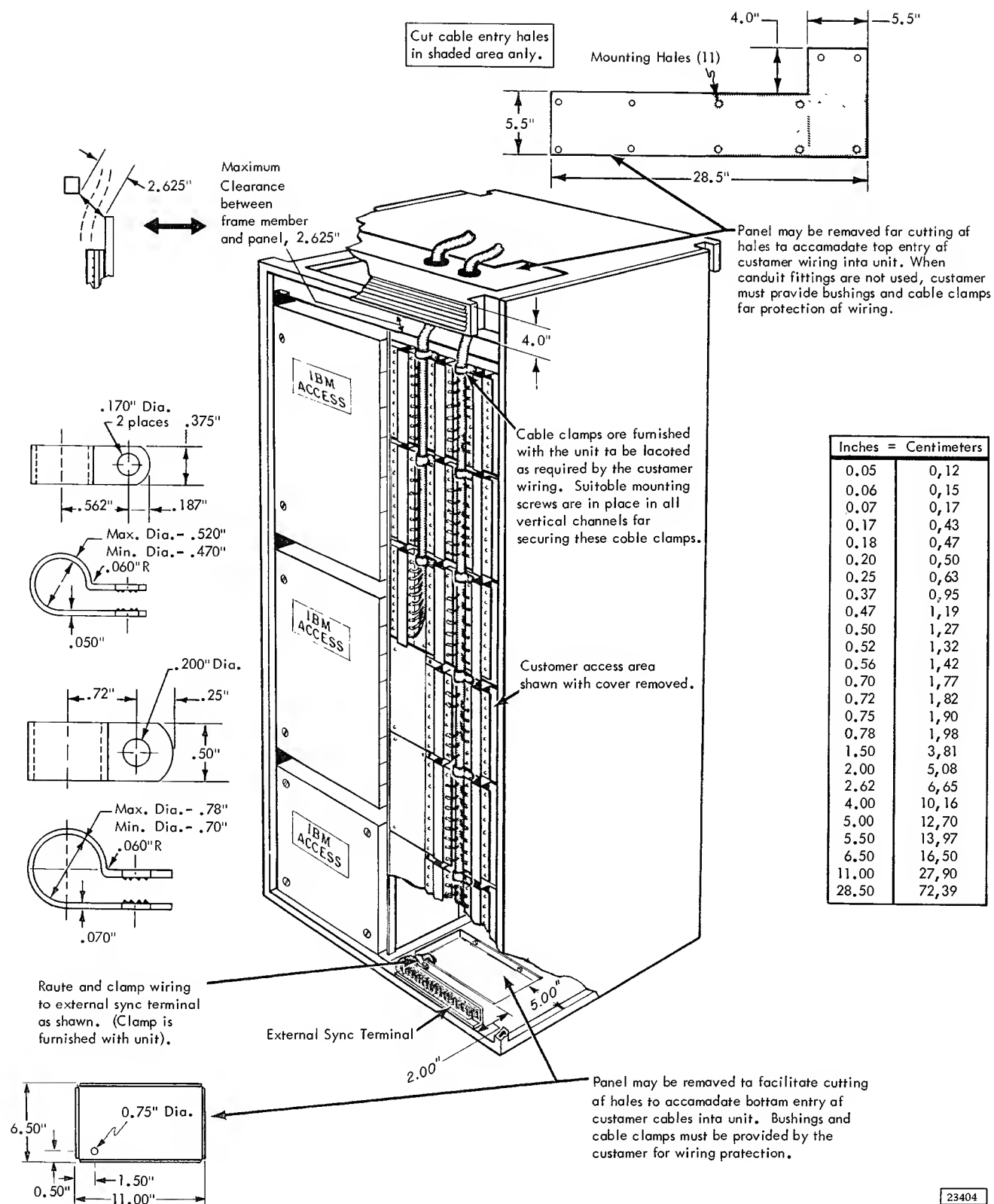


Figure 17. 1827 Customer Cable Routing

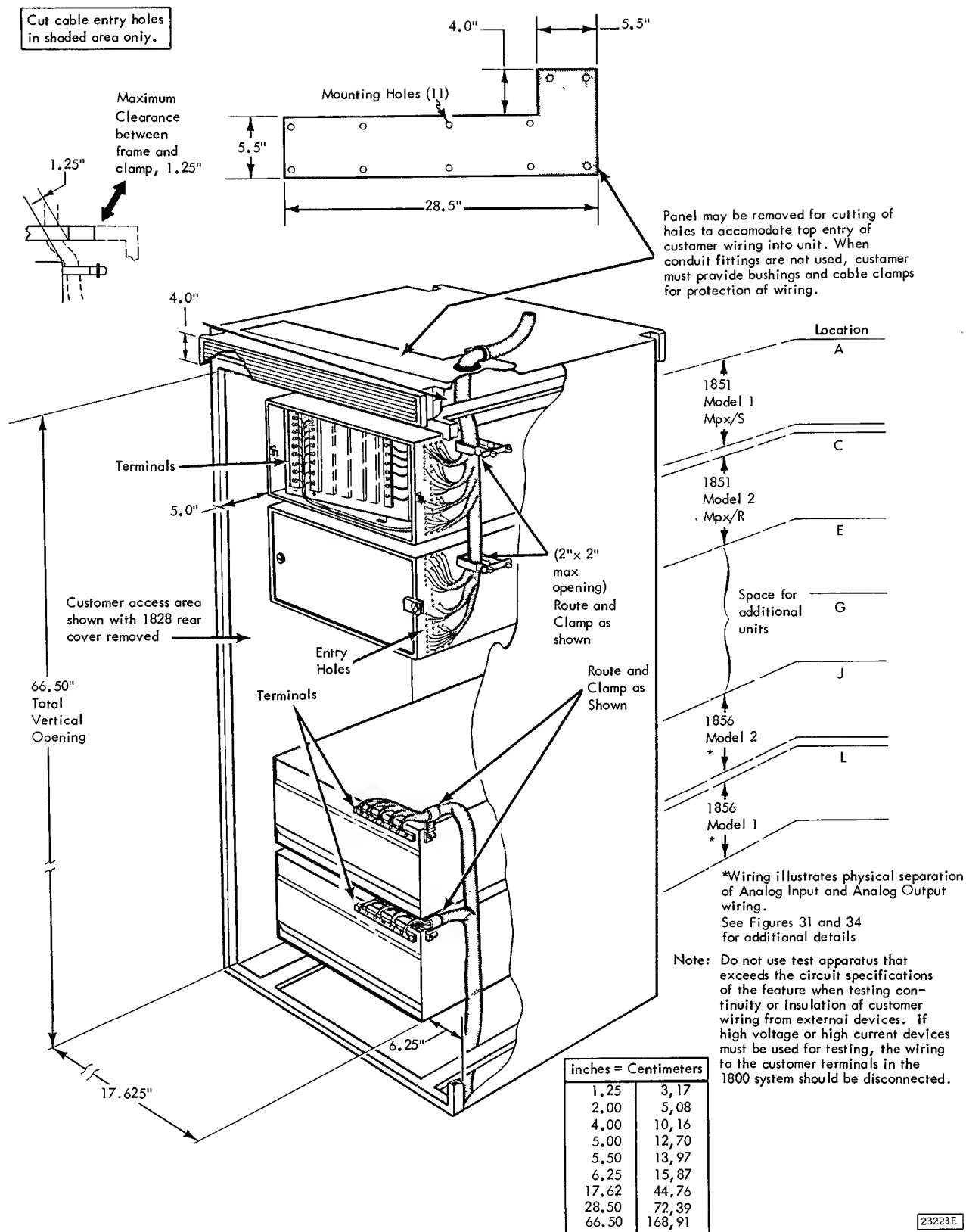


Figure 18. 1828 Typical Customer Terminations and Cable Routing and Internal Locations Designs



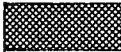

SECTION 3 UNIT SPECIFICATIONS

Plan views illustrated in this manual use the symbols shown below.

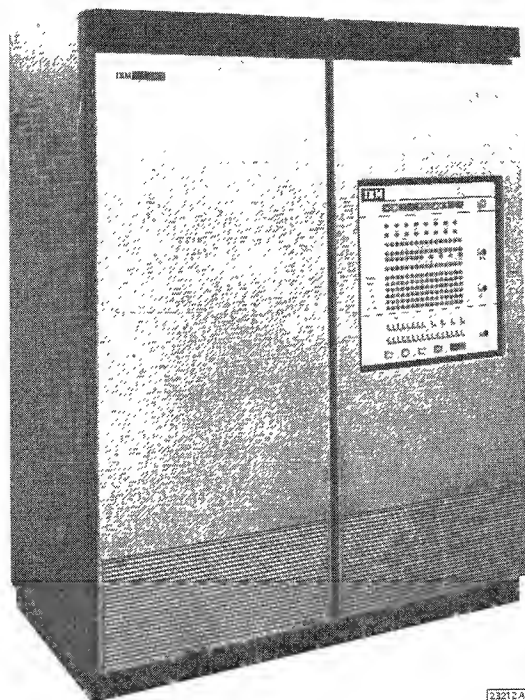
The customer cable entry areas in the machine top (1801, 1826, 1827, and 1828) are supplied with bolt-in steel cover panels. The top panel material is 0.060" (0,15 cm) thick. The cable entry area panel in the base of the 1826 is 0.048" (0,12 cm) thick. The panel in the base of the 1827 is 0.060" (0,15 cm) thick. These panels may be removed, modified for cable entry, and replaced.

Panels are not supplied for the cable entry areas in the base of the 1801 or the 1828.

Note: Plan views illustrated in this manual are not to scale. IBM provides templates that are drawn to scale dimensions. A list of applicable templates is contained in the Preface of this manual.

	IBM Cable Raised Floor Cutout
+	Caster
○	Floor Leveler
	Customer Cable Entry, Machine Base
	Customer Cable Entry, Machine Top
	Floor Level Cable Exit
⊕	Power Cable Exit

# IBM 1801 AND 1802 PROCESSOR-CONTROLLER



Dimensions--	Width (*1)	Depth (*2)	Height (*3)
Inches:	62	33	76.5
Centimeters:	157	84	194

Service Clearances--	Front	Rear	Left (*4)	Right (*4)
Inches:	36	36	30	30
Centimeters:	91	91	76	76

Maximum Weight-- 2,000 lb (907 kg)

Heat Output/hr. -- 9,500 BTU (2,394 kcal)

Air Flow-- 650 cfm (18,4 m<sup>3</sup>/m) maximum

## Electrical Requirements--

<u>60 Hertz</u>	<u>50 Hertz</u>
Phases: 3	Phases: 3
KVA: 3.0	KVA: 3.0
Plug: R & S 7328	Power Cord Style: E5
Receptacle: R & S 7324	
Connector: --R & S 7428	

## Operating Environment--

Temperature: 40° to 122°F (4.4° to 50°C)  
 Rel. Humidity: 8% to 95%  
 Mox. Wet Bulb: 85°F (29.4°C)

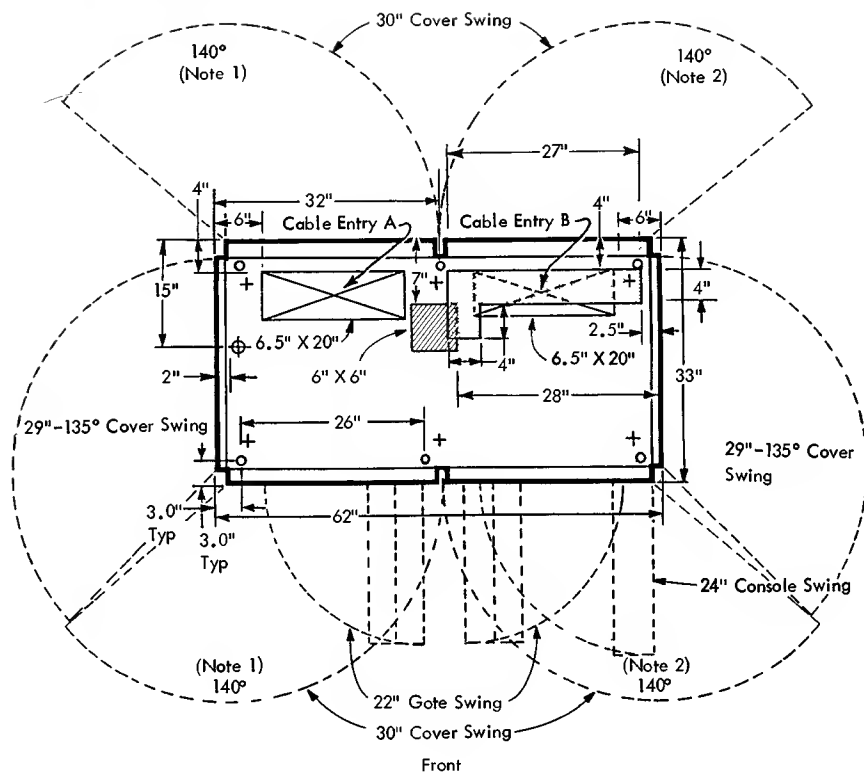
## Nonoperating Environment--

Temperature: 40° to 122°F (4.4° to 50°C)  
 Rel. Humidity: 8% to 95%  
 Mox. Wet Bulb: 85°F (29.4°C)

## \*Notes:

1. With side covers removed: 60.0" (152 cm)
2. With rear covers removed: 31.0" (79 cm)
3. 72.5" (184 cm) on shipping casters with top cover removed.
4. When not abutted to 1826 or 1828.

23438C



Inches = Centimeters	
2.0	5,0
2.5	6,3
3.0	7,6
4.0	10,1
6.0	15,2
6.5	16,5
7.0	17,7
15.0	38,1
20.0	50,8
22.0	55,8
24.0	60,9
26.0	66,0
27.0	68,5
28.0	71,1
29.0	73,6
30.0	76,2
32.0	81,3
33.0	83,8
62.0	157,4

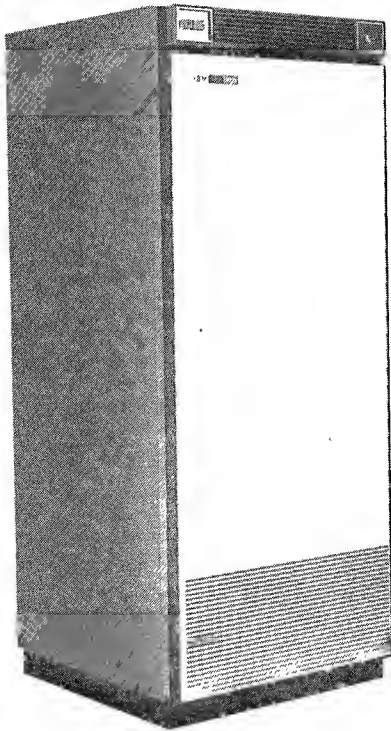
## Notes:

1. 100° if a unit is abutted to the left.
2. 100° if a unit is abutted to the right.
3. Front end/or rear kick strips may be removed when required for non-raised floor cable exits.

23142E



## IBM 1803 CORE STORAGE ADAPTER UNIT



20623

Dimensions--	Width (*1)	Depth (*2)	Height (*3)	
Inches:	32	33	76.5	
Centimeters:	81	84	194	
Service Clearances--	Front	Rear	Left *4	Right *4
Inches:	36	36	30	30
Centimeters:	91	91	76	76

Maximum Weight (\*5)-- 968 lb (439 kg)

Heat Output/hr.-- 1,800 BTU (,454 kcal)

Air Flow-- 490 cfm (14 m<sup>3</sup>/m) maximum

Electrical Requirements--  
KVA: 0.7

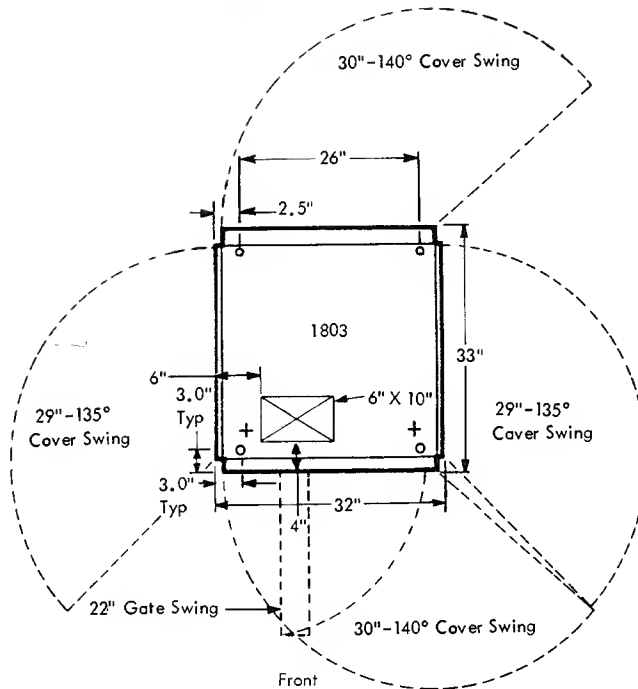
Operating Environment--  
Temperature: 40° to 105°F (4.4° to 42°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

Nonoperating Environment--  
Temperature: 40° to 122°F (4.4° to 50°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

\*Notes:

1. 30.0" (76 cm) with side covers removed.
2. 29.0" (74 cm) with front and rear covers removed.
3. 72.5" (184 cm) on shipping casters with top cover removed.
4. When not abutted to another system unit.
5. Maximum weight with all features installed.

20629

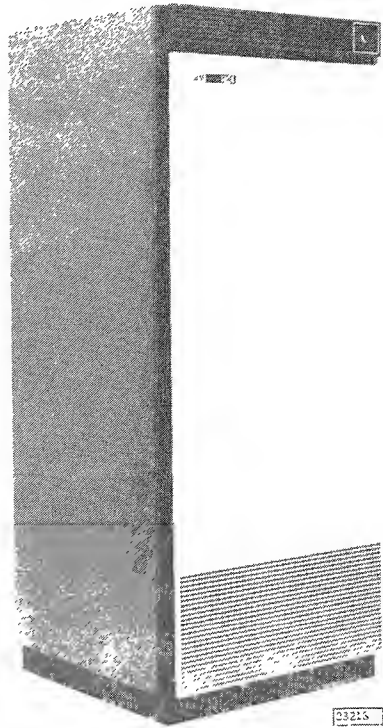


Inches = Centimeters	
2.5	6,3
3.0	7,6
4.0	10,1
6.0	15,2
6.5	16,5
7.0	17,7
10.0	25,4
20.0	50,8
22.0	55,8
26.0	66,0
29.0	73,6
30.0	76,2
32.0	81,3
33.0	83,8

Note: Front end/or rear kick strips may be removed when required for non-raised floor cable exits.

20624

IBM 1826 DATA ADAPTER UNIT



Dimensions--	Width (*1)	Depth (*2)	Height (*3)
Inches:	32	33	76.5
Centimeters:	81	84	194

Service Clearances--	Front	Rear	Left (*4)	Right (*4)
Inches:	36	36	30	30
Centimeters:	91	91	76	76

Maximum Weight (\*5)-- 968 lb (439 kg)

Heat Output/hr. (\*6)-- 4,600 BTU (1,159 kcal), Model 1  
2,500 BTU (,630 kcal), Model 2  
1,800 BTU (,454 kcal), Model 3

Air Flow-- 490 cfm (14 m<sup>3</sup>/m) maximum

Electrical Requirements--

KVA (\*B): Model 1 = 1.5  
Model 2 = 0.8  
Model 3 = 0.7

Operating Environment--

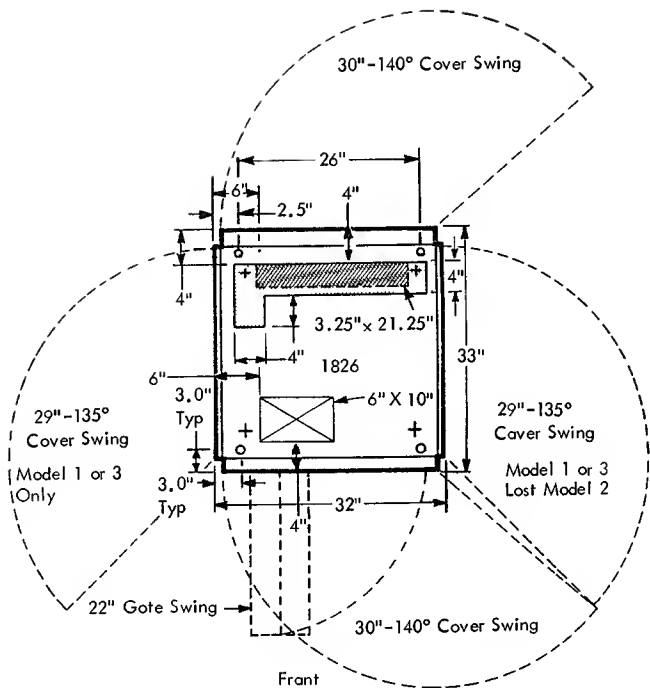
Temperature (\*9): 40° to 122° F (4.4° to 50° C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

Nonoperating Environment--

Temperature: 40° to 122°F (4.4° to 50°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

\*Notes:

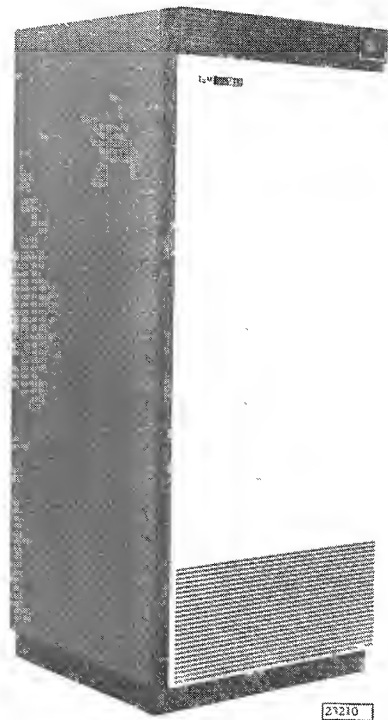
1. 30.0" (76 cm) with side covers removed.
2. 29.5" (74 cm) with front and rear covers removed.
3. 72.5" (184 cm) on shipping casters with top cover removed.
4. When not abutted to another system unit.
5. Maximum weight with all features installed.
6. Model 1 without AI Expander BTU = 3000 (,756 kcal).
7. Power supplied by 1801 or 1802.
8. Model 1 without AI Expander KVA = 1.0.
9. 40° to 105° F (4.4° to 41.6° C)  
if unit contains: Communications Adapter,  
Selector Channel, 2790 Adapter, or Expanded  
Data Channels.



Inches = Centimeters	
2.5	6,3
3.0	7,6
3.3	8,3
4.0	10,1
6.0	15,2
6.5	16,5
7.0	17,7
10.0	25,4
20.0	50,8
21.3	54,6
22.0	55,8
26.0	66,0
29.0	73,6
30.0	76,2
32.0	81,3
33.0	83,8

Note: Front and/or rear kick strips  
may be removed when required  
for non-raised floor cable exits.

IBM 1827 DATA CONTROL UNIT



Dimensions--	Width (*1)	Depth (*2)	Height (*3)
Inches:	32	33	76.5
Centimeters:	81	84	194
Service Clearances--	Front	Rear	Left (*4) Right (*4)
Inches:	36	36	30 30
Centimeters:	91	91	76 76

Maximum Weight (\*5)-- 1,000 lb (453 kg)

Heat Output/hr. -- 9,140 BTU (2,303 kcal)

Air Flow-- 490 cfm (14 m<sup>3</sup>/m) maximum.

Electrical Requirements--

60 Hertz	50 Hertz
Phases: 3	Phases: 3
KVA: 3.3	KVA: 3.3
Plug: R & S 7328	Pawer Card Style: E5
Receptacle: R & S 7324	
Connector: --R & S 7428	

Operating Envrinment--

Temperature: 40° to 122°F (4.4° to 50°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

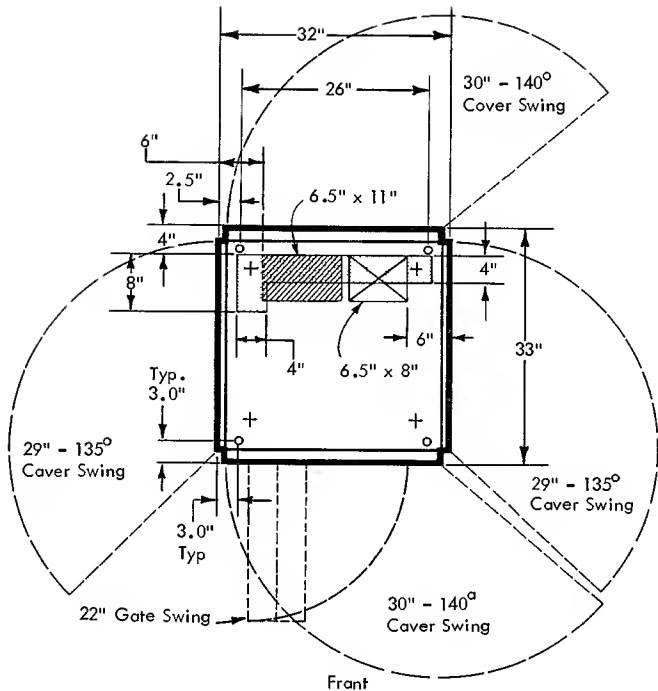
Nonoperating Envrinment--

Temperature: 40° to 122°F (4.4° to 50°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

\*Nates:

1. 30.0" (76 cm) with side covers removed.
2. 29.0" (74 cm) with frant and rear cavers removed.
3. 72.5" (184 cm) an shipping casters with top cover removed.
4. When not abutted to another system unit.
5. Maximum weight with all features installed.

23440B

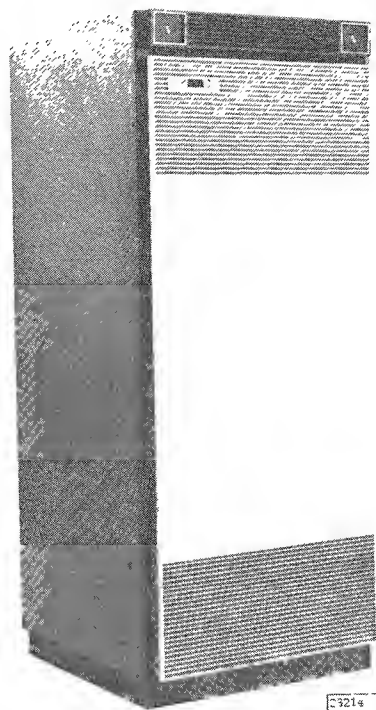


Inches	Centimeters
2.5	6,3
3.0	7,6
4.0	10,1
6.0	15,2
6.5	16,5
8.0	20,3
10.0	25,4
11.0	27,9
20.0	50,8
22.0	55,8
26.0	66,0
29.0	73,6
30.0	76,2
32.0	81,3
33.0	83,8

Note: Front and/or rear kick strips  
may be removed when required  
for non-raised flaar cable exits.

23216C

IBM 1828 ENCLOSURE



Dimensions--	Width (*1)	Depth (*2)	Height (*3)
Inches:	32	33	76.5
Centimeters:	81	84	194

Service Clearances--	Front	Rear	Left (*4)	Right (*4)
Inches:	36	36	30	30
Centimeters:	91	91	76	76

Maximum Weight (*5)	
Model 1:	642 lb (291 kg)
Model 2:	567 lb (258 kg)

Heat Output/hr. (\*6)-- 1,160 to 6,960 BTU (,292 to 1,754 kcal)

Air Flow -- 490 cfm (14m<sup>3</sup>/m) maximum

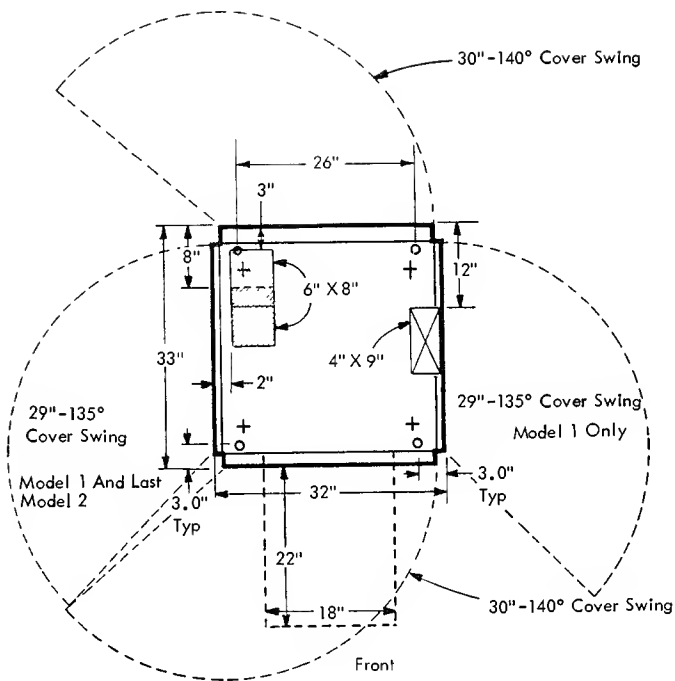
Electrical Requirements (\*7)  
0.4 KVA for each 1856 installed. Maximum of 6  
1856s for total KVA of 2.4.

Operating Environment--  
Temperature: 40° to 122°F (4.4° to 50°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

Nonoperating Environment--  
Temperature: 40° to 122°F (4.4° to 50°C)  
Rel. Humidity: 8% to 95%  
Max. Wet Bulb: 85°F (29.4°C)

- \*Notes:
1. 30.0" (76 cm) with side covers removed.
  2. 29.0" (74 cm) with front and rear covers removed.
  3. 72.5" (184 cm) on shipping cradle with top cover removed.
  4. When not obducted to another system unit.
  5. Maximum weight without 1851s or 1856s installed.  
Add weight of 1851s or 1856s (maximum of six  
units per 1828) to be installed in the specific  
enclosure. Weight: 1851 = 88 lb (40 kg); 1856 =  
140 lb (64 kg).
  6. 1160 BTU (292 kcal) per 1856 installed. BTU (kcal)  
value for 1851s is negligible.
  7. Power supplied by 1801 or 1802.

23441C

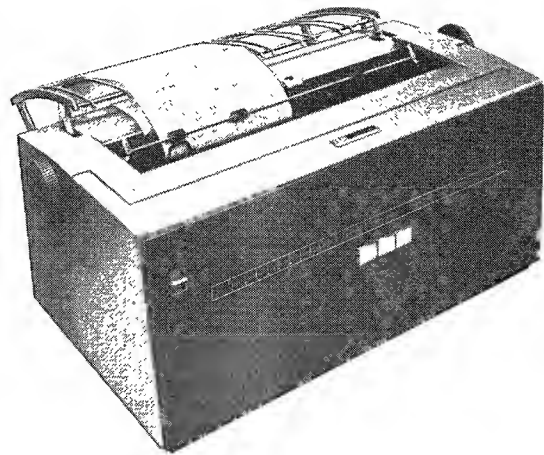


Inches = Centimeters	
2.0	5,0
3.0	7,6
4.0	10,1
6.0	15,2
8.0	20,3
9.0	22,8
12.0	30,4
18.0	45,7
22.0	55,8
26.0	66,0
29.0	73,6
30.0	76,2
32.0	81,3
33.0	83,8

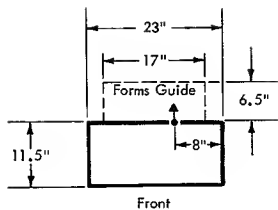
Note: Front and/or rear kick strips  
may be removed when required  
for non-raised floor cable exits.

23144D

IBM 1053 PRINTER, MODEL 3



15714C



Inches = Centimeters	
6.5	16,5
8.0	20,3
11.5	29,2
17.0	43,1
23.0	58,4

15714C

Dimensions--	Width (*1)	Depth	Height
Inches:	23	11.5	9
Centimeters:	58	29	23

Service Clearances--	Front	Rear	Left	Right
Inches:	12	12	12	12
Centimeters:	30	30	30	30

Maximum Weight-- 35 lb (16 kg)

Heat Output/hr. -- 335 BTU (,084 kcal)

Air Flow-- 0 cfm (0 m<sup>3</sup>/m)

Electrical Requirements (\*2)--

60 Hertz	50 Hertz
Phases: 1	Phases: 1
KVA: 0.1	KVA: 0.1
Plug: Hubbell #5666	Power Cord Style: G1
Receptacle: Hubbell #5661	
Connector: Hubbell #5669	

Operating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10% to 80%  
Max. Wet Bulb: 80°F (29°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10% to 80%  
Max. Wet Bulb: 80°F (29°C)

- \*Notes:
- Includes platen knobs that project 1.5" (9 cm) on each side
  - Electrical requirements for 115V option--  

60 Hertz	50 Hertz
Phases: 1	Phases: 1
KVA: 0.1	KVA: 0.1
Plug: P & S #5266	Power Cord Style: G1
Receptacle: P & S #5261	
or #5262	
Connector: P & S #5269	

23442C

IBM 1054 PAPER TAPE READER, MODEL 2



Dimensions (*1)--	Width	Depth	Height	
Inches:	22.75	13	6.6	
Centimeters:	57	33	17	
Service Clearances--	Front	Rear	Left	Right
Inches:	12	12	12	12
Centimeters:	30	30	30	30

Maximum Weight-- 20 lb (9 kg)

Heat Output/hr.-- 335 BTU (,084 kcal)

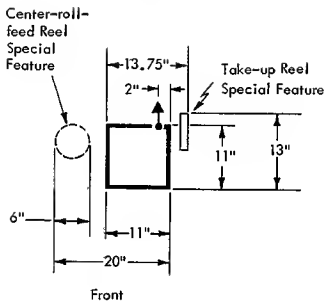
Air Flow-- 0 cfm (0 m<sup>3</sup>/m)

Electrical Requirements (\*2)--  
KVA: 0.1

Operating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10 to 80%  
Max. Wet Bulb: 80°F (27°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10 to 80%  
Max. Wet Bulb: 80°F (27°C)

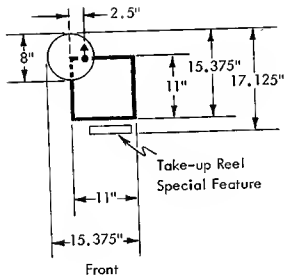
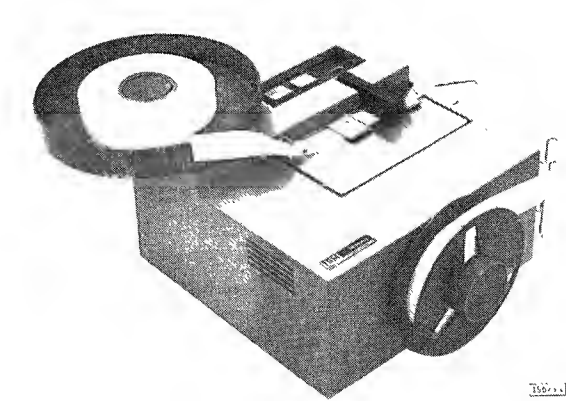
- \*Notes:
1. Dimensions include feed and take-up reels.
  2. Power supplied by 1801/1802.



Inches = Centimeters	
2.00	5,1
6.00	15,2
11.00	29,9
13.00	33,0
13.75	34,9
20.00	50,8

23443B

IBM 1055 PAPER TAPE PUNCH, MODEL 2



Inches = Centimeters	
2.50	6,4
8.00	20,3
11.00	27,9
15.37	39,0
17.12	43,4

Dimensions (*1)--	Width	Depth	Height
Inches:	15.375	17.125	8.25
Centimeters:	39	44	21

Service Clearances--	Front	Rear	Left	Right
Inches:	12	12	12	12
Centimeters:	30	30	30	30

Maximum Weight-- 26 lb (12 kg)

Heat Output/hr.-- 335 BTU (,084 kcal)

Air Flow-- 0 cfm (0 m<sup>3</sup>/m)

Electrical Requirements (\*2)--  
KVA: 0.1

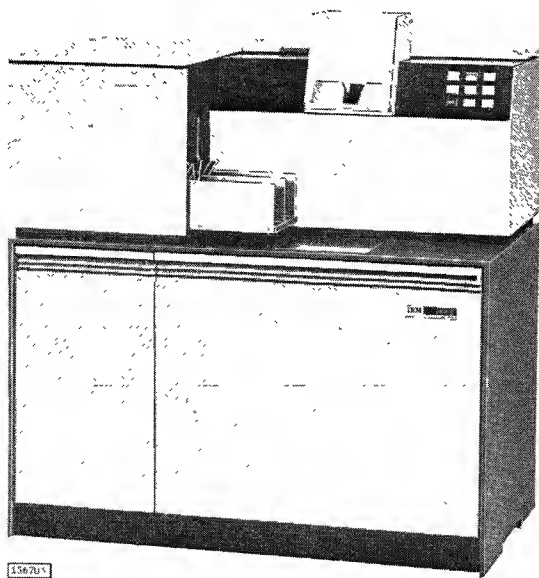
Operating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10% to 80%  
Max. Wet Bulb: 80°F (29°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10% to 80%  
Max. Wet Bulb: 80°F (29°C)

- \*Notes:
1. Width and depth dimensions include tape reels.
  2. Power supplied by 1801/1802.

23444B

IBM 1442 CARD READ PUNCH, MODEL 6 AND MODEL 7



Dimensions--	Width	Depth	Height
Inches:	43	24	49
Centimeters:	109	61	124

Service Clearances--	Front	Rear	Left (*1)	Right
Inches:	36	30	18	6
Centimeters:	91	76	46	15

Maximum Weight-- 520 lb (236 kg)

Heat Output/hr. -- 1800 BTU (,454 kcal)

Air Flow-- 50 cfm (1,4 m<sup>3</sup>/m)

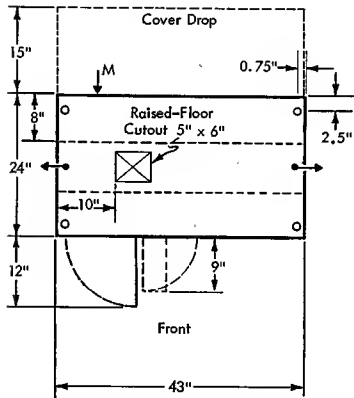
Electrical Requirements (\*2)--  
KVA: 0.7

Operating Environment--  
Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 20% to 80%  
Max. Wet Bulb: 78°F (26°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 8% to 80%  
Max. Wet Bulb: 80°F (27°C)

- \*Notes:
1. Left service clearance not required from floor level to 30" (76 cm) above the floor.
  2. Power supplied by 1801/1802.

23445B

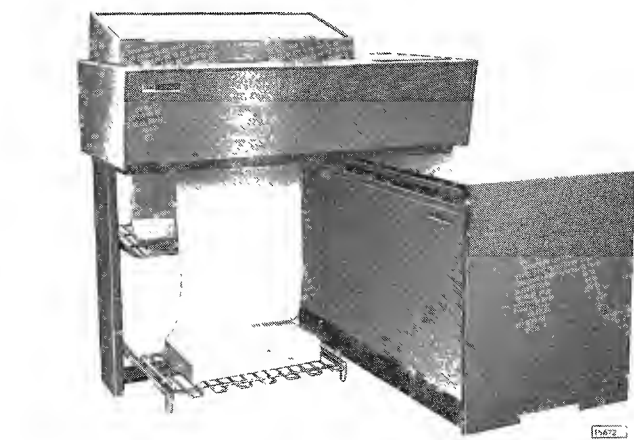


Inches = Centimeters	
0.5	1,2
0.75	1,9
2.5	6,3
5.0	12,7
6.0	15,2
8.0	20,3
9.0	22,8
10.0	25,4
12.0	30,4
15.0	38,1
24.0	60,9
43.0	109,2

15708C



**BM 1443 PRINTER, MODEL 1 AND MODEL 2**



Dimensions--	Width	Depth (*1)	Height
Inches:	55.9	43	46
Centimeters:	142	109	117

Service Clearances--	Front (*2)	Rear	Left	Right
Inches:	36	36	30	36
Centimeters:	91	91	76	91

Maximum Weight-- 731 lb (332 kg)

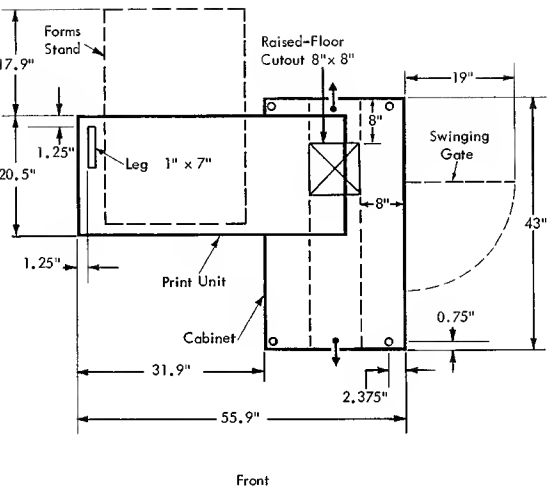
Heat Output/hr.-- 2,450 BTU (, 617 kcal)

Air Flow-- 416 cfm (11,8 m<sup>3</sup>/m)

Electrical Requirements (\*3)--  
KVA. 1.1

Operating Environment--  
Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 20% to 80%  
Max. Wet Bulb: 78°F (26°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 8% to 80%  
Max. Wet Bulb: 80°F (27°C)



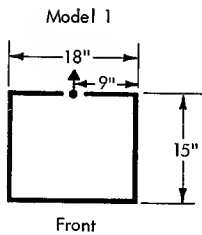
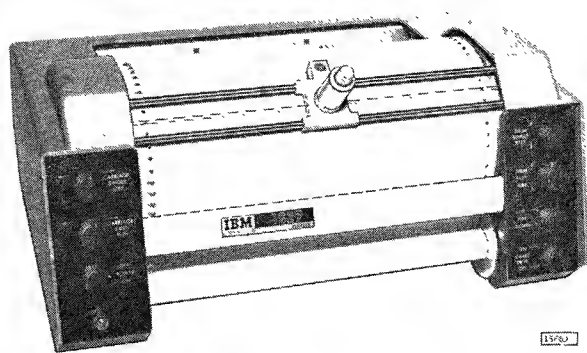
Inches = Centimeters	
0.75	1,9
1.00	2,5
1.25	3,6
2.37	5,8
7.00	17,7
8.00	20,3
17.90	45,4
19.00	48,2
20.50	51,9
31.90	81,0
43.00	109,2
55.90	141,9

- \*Notes:
1. Forms stand projects 17.9" (45 cm) to the rear of print unit. For shipment, the forms stand is removed and the print unit is rotated over the cabinet. Shipping dimensions are 24" X 48.5" X 46" (61 cm X 123 cm X 117 cm).
  2. Front clearance applies only to the area in front of the print unit.
  3. Power supplied by 1801/1802.

23446B

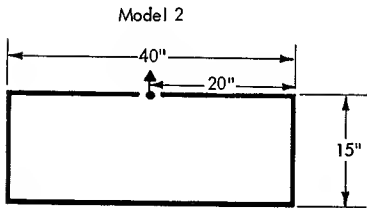
B5710C

IBM 1627 PLOTTER, MODEL 1 AND MODEL 2



Front

Inches = Centimeters	
9.0	22,9
15.0	38,1
18.0	45,7
20.0	50,8
40.0	101,6



Front

Dimensions Model 1--	Width	Depth	Height
Inches:	18	15	10
Centimeters:	46	38	25

Dimensions Model 2--	Width	Depth	Height
Inches:	40	15	10
Centimeters:	102	38	25

Service Clearances--	Front	Reor	Left	Right
Inches:	12	12	12	12
Centimeters:	30	30	30	30

Maximum Weight--	
Model 1:	33 lb (15 kg)
Model 2:	55 lb (25 kg)

Heat Output/hr.-- 375 BTU (,095 kcal)

Air Flow-- 0 cfm (0 m<sup>3</sup>/m)

Electrical Requirements (\*1)--  
KVA: 0.1

Operating Environment:  
Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 20% to 80%  
Max. Wet Bulb: 78°F (26°C)

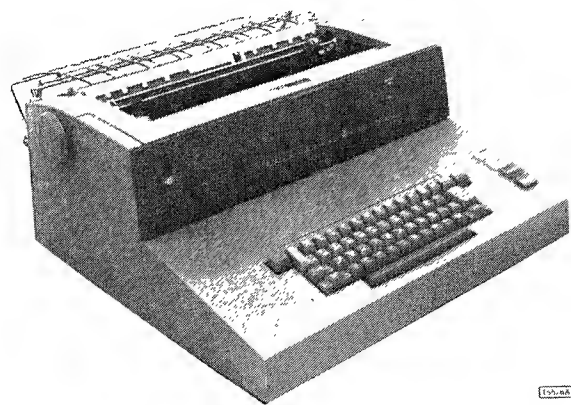
Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 8% to 80%  
Max. Wet Bulb: 80°F (27°C)

\*Notes:  
1. Power supplied by 1801/1802.

23447B

15706B

IBM 1816 PRINTER-KEYBOARD



15758A

Dimensions--	Width (*1)	Depth	Height
Inches:	23	19.75	9
Centimeters:	56	50	23

Service Clearances--	Front	Rear	Left	Right
Inches:	12	12	12	12
Centimeters:	30	30	30	30

Maximum Weight-- 65 lb (30 kg)

Heat Output/hr. -- 335 BTU (,084 kcal)

Air Flow-- 0 cfm (0 m<sup>3</sup>/m)

Electrical Requirements (\*2)--

60 Hertz

Phases: 1  
KVA: 0.1  
Plug: Hubbell #5666  
Receptacle: Hubbell #5661  
Connector: Hubbell #5669

50 Hertz

Phases: 1  
KVA: 0.1  
Power Cord Style: G1

Operating Environment--

Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10% to 80%  
Max. Wet Bulb: 80°F (29°C)

Nonoperating Environment--

Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 10% to 80%  
Max. Wet Bulb: 80°F (29°C)

\*Notes:

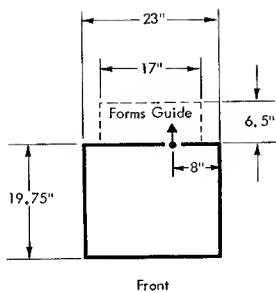
1. Includes platen knobs that project 1.5" (9 cm) on each side.
2. Electrical requirements for 115V option--

60 Hertz

Phases: 1  
KVA: 0.1  
Plug: P & S #5266  
Receptacle: P & S #5261  
or #5262  
Connector: P & S #5269

50 Hertz

Phases: 1  
KVA: 0.1  
Power Cord Style: G1



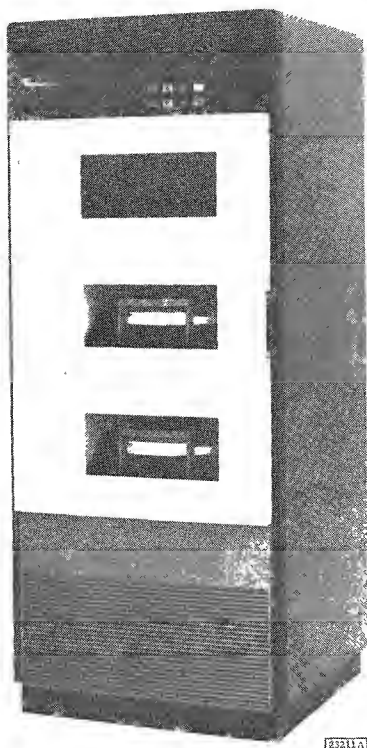
Front

Inches = Centimeters	
6.50	16,5
8.00	20,3
17.00	43,1
19.75	50,1
23.00	58,4

15712C

23448C

IBM 1810 DISK STORAGE, MODELS A1, A2, A3, B1,  
B2, AND B3



Dimensions--	Width (*1)	Depth (*2)	Height (*3)
Inches:	32	33	76.5
Centimeters:	81	84	194

Service Clearances--	Front	Rear	Left	Right
Inches:	36	36	32	32
Centimeters:	91	91	81	81

Maximum Weight--	
Model A1 or B1:	850 lb (386 kg)
Model A2 or B2:	930 lb (422 kg)
Model A3 or B3:	1,010 lb (458 kg)

Heat Output/hr. --	
Model A1 or B1:	2,840 BTU (,716 kcal)
Model A2 or B2:	3,960 BTU (,998 kcal)
Model A3 or B3:	5,120 BTU (1,290 kcal)

Air Flow--	
Model A1 or B1:	150 cfm (4,2 m <sup>3</sup> /m)
Model A2 or B2:	225 cfm (6,4 m <sup>3</sup> /m)
Model A3 or B3:	300 cfm (8,5 m <sup>3</sup> /m)

Electrical Requirements (*4)--	
KVA-- Model A1 or B1:	0.83
Model A2 or B2:	1.16
Model A3 or B3:	1.5

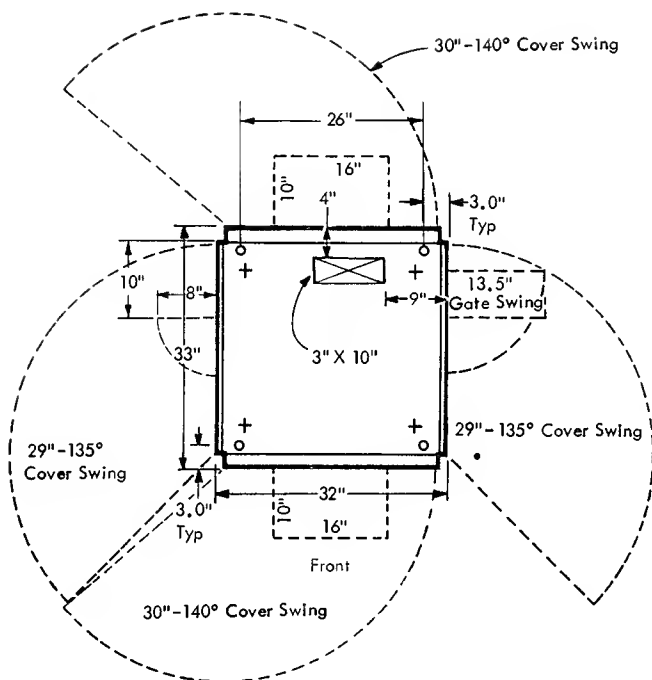
Operating Environment--	
Temperature:	50° to 105°F (10° to 42°C)
Rel. Humidity:	8% to 80%
Max. Wet Bulb:	85°F (29°C)

Nonoperating Environment--	
Temperature:	50° to 150°F (10° to 66°C)
Rel. Humidity:	8% to 80%
Max. Wet Bulb:	85°F (29°C)

\*Notes:

1. 27.75" (69 cm) with side covers removed.
2. 29" (74 cm) with front and rear covers removed.
3. 72.5" (184 cm) on shipping casters with top cover removed.
4. Power supplied by 1801/1802.

23449 C



Inches	Centimeters
3.0	7,6
4.0	10,1
8.0	20,3
9.0	22,8
10.0	25,4
13.5	34,2
16.0	40,6
26.0	66,0
29.0	73,6
30.0	76,2
32.0	81,3
33.0	83,8

Note: Front and/or rear kick strips may be removed when required for non-raised floor cable exits.

23145D

## IBM 2311 DISK STORAGE DRIVE



Dimensions--	Width	Side	Height
Inches:	30	24	38
Centimeters:	76,2	61,0	96,5

Service Clearances--	Front	Rear	Right (*2)	Left (*2)
Inches:	36	36	30	30
Centimeters:	91,4	91,4	76,2	76,2

Maximum Weight-- 390 lb (177 kg)

Heat Output/hr.-- 2,000 BTU/hr (,504 kcal)

Air Flow-- 100 cfm (3 m<sup>3</sup>/m)

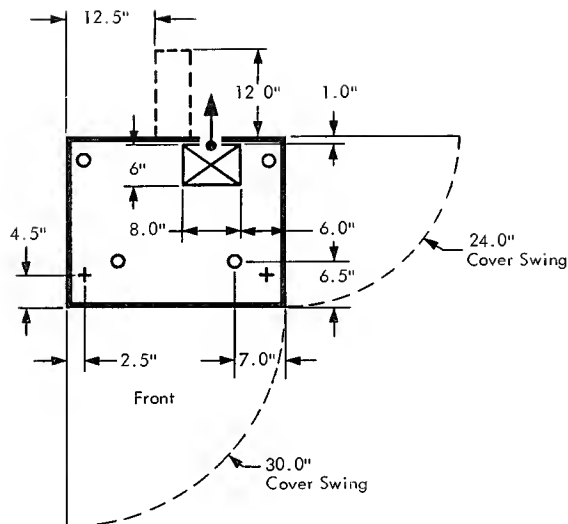
Electrical Requirements--(\*1)  
KVA 0.75

Operating Environment--  
Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 8% to 80%

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 0% to 80%

\*Notes:  
1. Powered from control unit.  
2. When not abutted to units of like construction.

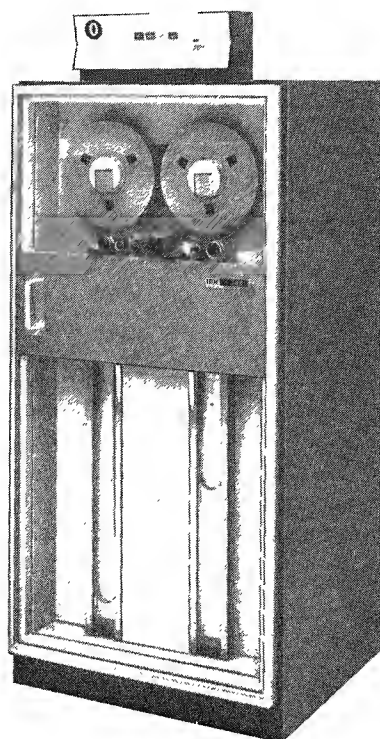
20625



Inches = Centimeters	
1.00	2,5
2.50	6,4
4.50	11,4
6.00	15,2
6.50	16,5
7.00	17,8
8.00	20,3
12.00	30,5
12.50	31,8
24.00	61,0
30.00	76,2

20627

# IBM 2401 MAGNETIC TAPE UNIT, MODELS 1, 2, AND 3



15721

Dimensions--	Width	Depth	Height
Inches:	30	29	60
Centimeters:	76	74	152

Service Clearances--	Front	Rear	Left (*1)	Right (*1)
Inches:	36	36	30	30
Centimeters:	91	91	76	76

Maximum Weight-- 800 lb (362 kg)

Heat Output/hr. -- 3,500 BTU (,882 kcal)

Air Flow-- 500 cfm (14,2 m<sup>3</sup>/m)

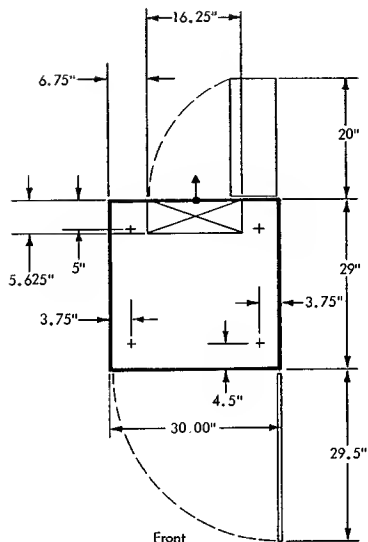
Electrical Requirements (\*2)--  
KVA: 1.6

Operating Environment--  
Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 20% to 80%  
Max. Wet Bulb: 78°F (26°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 8% to 80%  
Max. Wet Bulb: 80°F (27°C)

\*Notes:  
1. When not abutted to another tape unit.  
2. Power supplied by 1802.

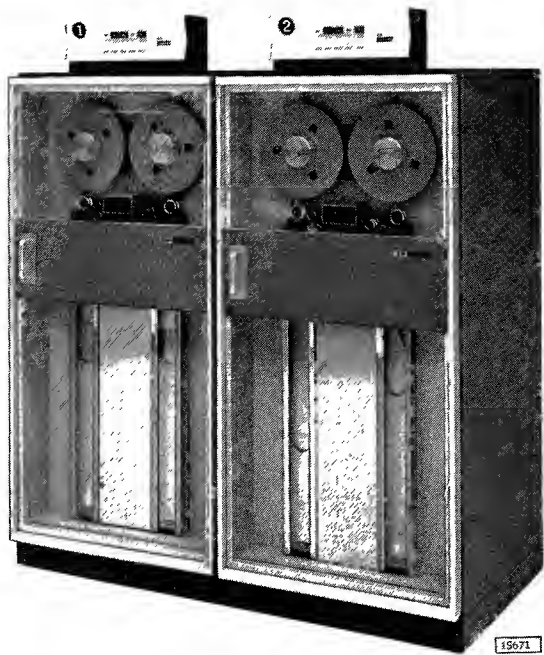
23450A



Inches = Centimeters	
3.75	9,5
4.50	11,4
5.00	12,7
5.62	14,2
6.75	17,0
16.25	41,1
20.00	50,8
29.50	74,9
30.00	76,2

15722-C

IBM 2402 MAGNETIC TAPE UNIT, MODELS 1, 2, AND 3



Dimensions--	Width	Depth	Height
Inches:	60	29	60
Centimeters:	152	74	152

Service Clearance--	Front	Rear	Left	Right
Inches:	36	36	30	30
Centimeters:	91	91	76	76

Maximum Weight-- 1,600 lb (725 kg)

Heat Output/hr. -- 7,000 BTU (1,764 kcal)

Air Flow-- 1,000 cfm (28,3 m<sup>3</sup>/m)

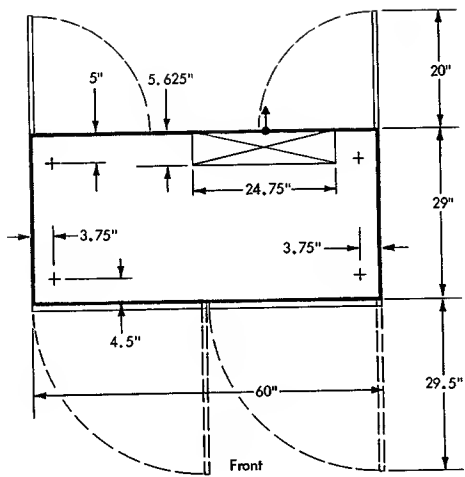
Electrical Requirements (\*1)--  
KVA: 3.2

Operating Environment--  
Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 20% to 80%  
Max. Wet Bulb: 78°F (26°C)

Nonoperating Environment--  
Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 8% to 80%  
Max. Wet Bulb: 80°F (27°C)

\*Notes:  
1. Power supplied by 1802.

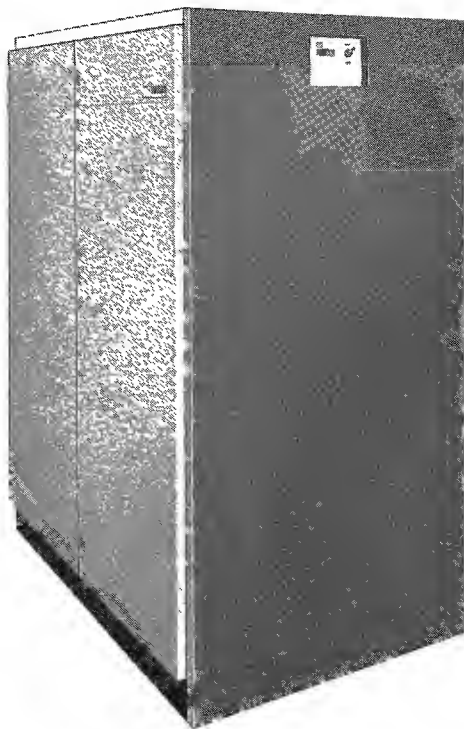
23451B



Inches = Centimeters	
3.75	9,5
4.50	11,4
5.00	12,7
5.62	14,2
20.00	50,8
24.75	62,8
29.00	73,6
60.00	152,4

15724B

IBM 2841 STORAGE CONTROL UNIT



20633

Dimensions--	Width	Depth	Height
Inches:	32	45.5	60
Centimeters:	81,3	115,5	152,4

Service Clearances--	Front	Rear	Left	Right
Inches:	30	30	48	30
Centimeters:	76,2	76,2	121,9	76,2

Maximum Weight-- 750 lb (340 kg)

Heat Output/hr.-- 3,100 BTU/hr (,781 kcal)

Air Flow-- 1,000 cfm (28 m<sup>3</sup>/m)

Electrical Requirements--

60 Hertz	50 Hertz
Phases: 3	Phases: 3
KVA: 1.1	KVA: 1.1
Plug: R & S, FS3760	Power Card Style: D2
Connector: R & S, FS3934	

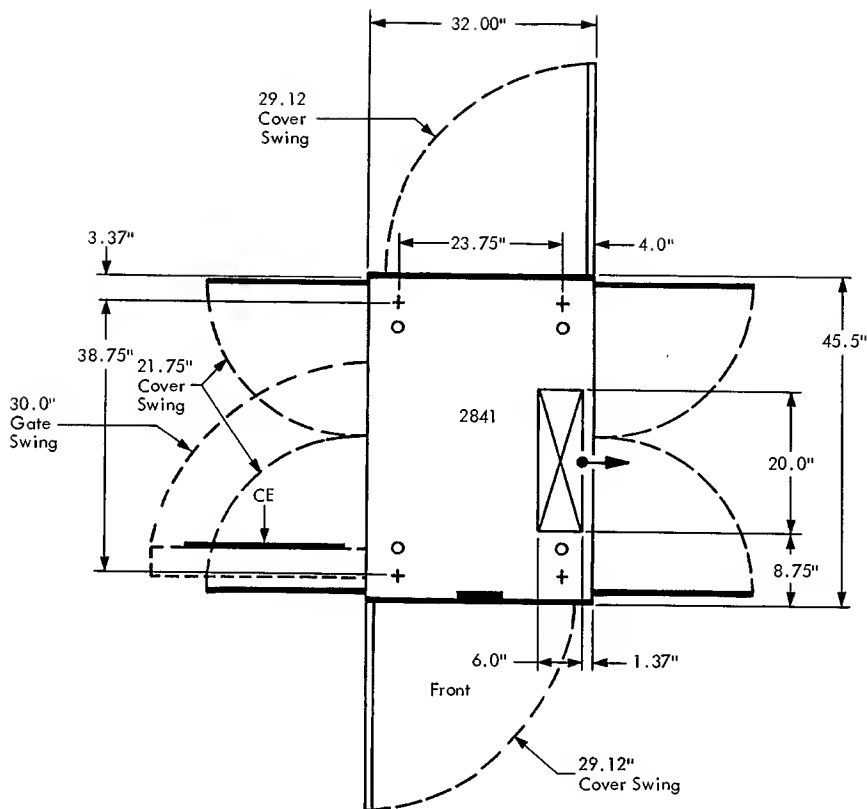
Operating Environment--

Temperature: 60° to 90°F (16° to 32°C)  
Rel. Humidity: 20% to 80%  
Max. Wet Bulb: 78°F (26°C)

Nonoperating Environment--

Temperature: 50° to 110°F (10° to 43°C)  
Rel. Humidity: 8% to 80%  
Max. Wet Bulb: 80°F (27°C)

20626A

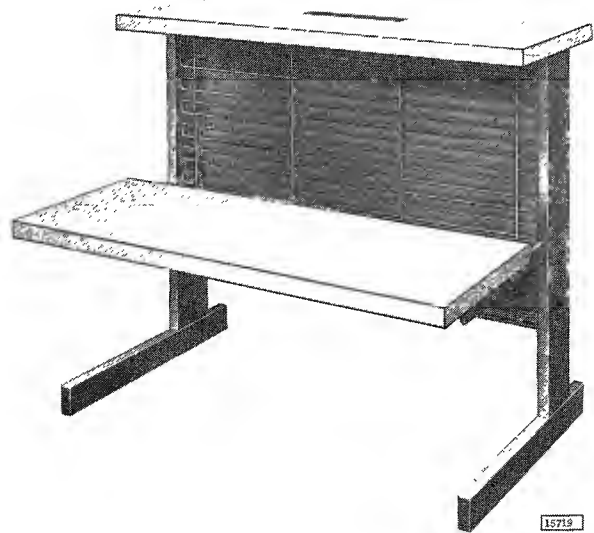


Inches = Centimeters	
1.37	3,5
3.37	8,6
4.00	10,2
6.00	15,2
6.87	17,5
8.75	22,2
20.00	50,8
21.75	55,2
23.75	60,3
29.12	74,0
30.00	76,2
32.00	81,3
38.75	98,4
45.50	115,6

20628A



**AUXILIARY TABLE**



Dimensions (overall)--	Width	Depth (*1)	Height
Inches:	32	23	27
Centimeters:	81	58	69

Dimensions (top shelf)--	Width	Depth	Height (*2)
Inches:	32	12	27
Centimeters:	81	30	69

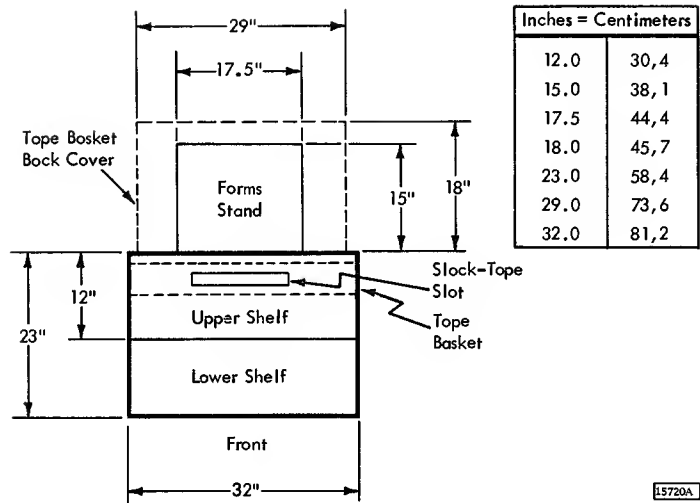
Dimensions (bottom shelf)--	Width	Depth	Height (*2)
Inches:	32	12	15
Centimeters:	81	30	38

Distance between shelves-- 12 inches (30 cm)

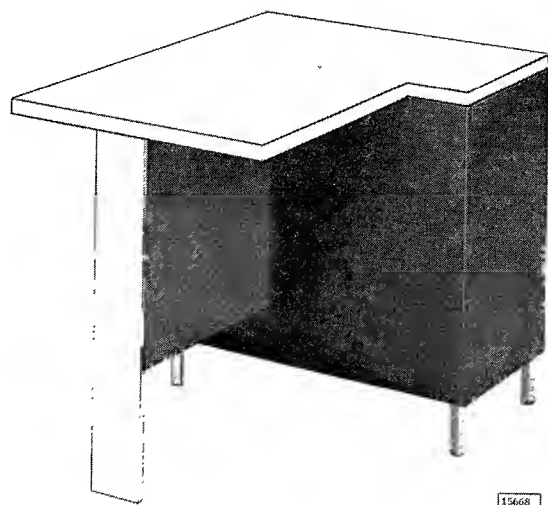
Maximum Weight-- 30 lb (13,6 kg)

- \*Notes:
1. This dimension is decreased by 3 inches (7,6 cm) when the lower shelf is repositioned to the rear.
  2. Above floor.

The Auxiliary Table is available from IBM (accessory), but is not standard with the 1800 System. It is for use with the 1053, 1054, and 1055 units. A bin for slack tape is provided for temporary storage of punched tape.



## TABLE FOR 1816



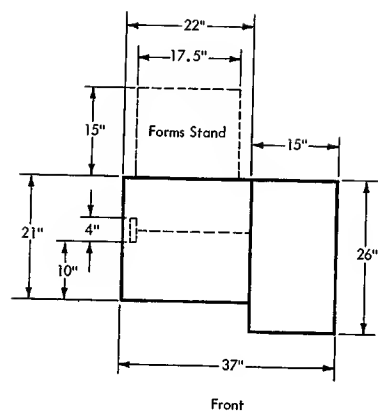
15668

Dimensions--	Width	Depth	Height
Inches:	37	26	27
Centimeters:	94	66	69

Maximum Weight-- 50 lb (22,6 kg)

This table is available from IBM (accessory), but is not standard with the 1800 System. The Table is free standing and provides table space to the right of the 1816. A form stand permits feeding and stacking of continuous paper forms.

23453



Front

157468

Inches = Centimeters	
4.0	10,1
10.0	25,4
15.0	38,1
17.5	44,4
21.0	53,3
22.0	55,8
26.0	66,0
37.0	93,9

DIGITAL INPUT AND DIGITAL OUTPUT FEATURES

As described in the 1801/1802 and 1826 Sections of this manual, Digital Input and Digital Output features are installed and provide for customer termination in the 1801 and/or the 1826. These features are installed on one or more of four different adapters.

ADAPTERS AND FEATURES

Digital Input Adapter (#3262)

A maximum of 8 groups may be installed per adapter (numbered 0 through 7).

- Digital Input – Contact, group of 16 bits (#3285)
- Digital Input – Voltage, group of 16 bits (#3286)

Pulse Counter Adapter (#5861)

A maximum of 16 8-bit counters (numbered 0 through 15) or 8 16-bit counters (numbered 0, 2, 4, ... 14) are available per adapter.

- Pulse Counter, 8-bit (#5862)
- Pulse Counter, 16-bit (#5867)

Process Interrupt Adapter #5710)

A maximum of 3 groups per adapter (numbered 1 through 3).

- Process Interrupt – Voltage, group of 16 points (#5716)
- Process Interrupt – Contact, group of 16 points (#5715)

Digital Output Adapter (#3295)

A maximum of 4 groups per adapter (numbered 0 through 3).

- Electronic "Contact" Operate, group of 16 bits (#3612)
- Pulse Output, group of 16 bits (#5863)
- Register Output, each 16 bit register (#6125)

COMBINATIONS AND LIMITATIONS

The 1801 can have a maximum of four Digital I/O Adapters installed in selected combinations.

1. Digital Output Adapter
2. Pulse Counter OR Process Interrupt OR Digital Output OR Digital Input Adapter
3. Digital Input Adapter
4. Process Interrupt OR Pulse Counter Adapter

Terminal points available: 368

The 1826 can have a maximum of six Digital I/O Adapters installed.

1. Digital Output Adapter
2. Digital Output Adapter
3. Pulse Counter OR Process Interrupt OR Digital Output Adapter
4. Pulse Counter OR Process Interrupt OR Digital Input OR Digital Output Adapter
5. Digital Input Adapter
6. Pulse Counter OR Digital Input Adapter

Terminal points available: 576

The 1827 can have a maximum of three Digital I/O Adapters installed.

1. Digital Input Adapter OR Digital Output Adapter OR Pulse Counter
2. Digital Input Adapter OR Digital Output Adapter OR Pulse Counter
3. Pulse Counter OR Digital Output Adapter

Terminal points available: 288

Each terminal point provides a pair of terminals for the signal and return connection of Digital I/O. The terminals are divided into blocks of 16 points each (23 blocks maximum in 1801; 36 blocks maximum in 1826; 18 blocks maximum in the 1827).

Note: One terminal block accommodates all 16 8-bit pulse counters or 8 16-bit pulse counters for one Pulse Counter Adapter.

Different functions cannot be placed on the same block of terminals. Figures 12, 15, and 16 in Section 2 illustrate the physical location of the terminal blocks. Figure 19 illustrates how the various feature adapters are associated with the terminal blocks. Only terminal blocks that are

Figure 19. Adapter—Terminal Area Locations (Customer Terminations)

1801						1826						1827		
<b>A1</b> Group 0 of 1st DO	<b>B1</b> Group 4 of 2nd DI	<b>C1</b> 1st/2nd PCA or Group 0 of 2nd DO or 2nd DI or Group 1 of 2nd PI	<b>D1</b> Group 4 of 1st DI	<b>E1</b> Group 0 of 1st DI	<b>F1</b> 1st PCA or Group 1 of 1st PI	<b>A1</b> Group 2 of 2nd DO	<b>B1</b> 1st/2nd PCA or Group 0 of 3rd DO or Group 1 of 1st PI	<b>C1</b> Group 2 of 4th DO or 3rd DI or Group 3 of 1st/2nd PI	<b>D1</b> Group 4 of 2nd DI	<b>E1</b> Group 6 of 1st DI	<b>F1</b> Group 0 of 1st DI	<b>A1</b> 1st PCA or Group 0 of 1st DI or 1st DO	<b>B1</b> Group 6 of 1st DI	<b>C1</b> Group 4 of 2nd DI or Group 0 of 1st, 2nd or 3rd DO
<b>A2</b> Group 1 of 1st DO	<b>B2</b> Group 5 of 2nd DI	<b>C2</b> Group 1 of 2nd DO or 2nd DI or Group 2 of 2nd PI	<b>D2</b> Group 5 of 1st DI	<b>E2</b> Group 1 of 1st DI	<b>F2</b> Group 2 of 1st PI	<b>A2</b> Group 3 of 2nd DO	<b>B2</b> Group 1 of 3rd DO or Group 2 of 1st PI	<b>C2</b> Group 3 of 4th DO or 3rd DI	<b>D2</b> Group 5 of 2nd DI	<b>E2</b> Group 7 of 1st DI	<b>F2</b> Group 1 of 1st DI	<b>A2</b> Group 1 of 1st DI or 1st DO	<b>B2</b> Group 7 of 1st DI	<b>C2</b> Group 5 of 2nd DI or Group 1 of 1st, 2nd or 3rd DO
<b>A3</b> Group 2 of 1st DO	<b>B3</b> Group 6 of 2nd DI	<b>C3</b> Group 2 of 2nd DO or 2nd DI or Group 3 of 2nd PI	<b>D3</b> Group 6 of 1st DI	<b>E3</b> Group 2 of 1st DI	<b>F3</b> Group 3 of 1st PI	<b>A3</b> Group 0 of 1st DO	<b>B3</b> Group 2 of 3rd DO or Group 3 of 1st PI	<b>C3</b> Group 4 of 3rd DI	<b>D3</b> Group 6 of 2nd DI	<b>E3</b> 1st PCA or Group 0 of 2nd DI	<b>F3</b> Group 2 of 1st DI	<b>A3</b> Group 2 of 1st DI or 1st DO	<b>B3</b> Group 0 of 2nd DI or 1st/2nd DO	<b>C3</b> Group 6 of 2nd DI or Group 2 of 1st, 2nd or 3rd DO
<b>A4</b> Group 3 of 1st DO	<b>B4</b> Group 7 of 2nd DI	<b>C4</b> Group 3 of 2nd DO or 2nd DI	<b>D4</b> Group 7 of 1st DI	<b>E4</b> Group 3 of 1st DI		<b>A4</b> Group 1 of 1st DO	<b>B4</b> Group 3 of 3rd DO	<b>C4</b> Group 5 of 3rd DI	<b>D4</b> Group 7 of 2nd DI	<b>E4</b> Group 1 of 2nd DI	<b>F4</b> Group 3 of 1st DI	<b>A4</b> Group 3 of 1st DI or 1st DO	<b>B4</b> Group 1 of 2nd DI or 1st/2nd DO	<b>C4</b> Group 7 of 2nd DI or Group 3 of 1st, 2nd or 3rd DO
<p>For Digital Output Adapters #3295 (DO), installed within a specific unit, the installation sequence of the feature groups will be:</p> <ol style="list-style-type: none"> <li>1. All Electronic "Contact" Operate (#3612) groups followed by-</li> <li>2. All Pulse Output (#5863) groups followed by-</li> <li>3. All Register Output (#6125) groups.</li> </ol>						<p>For Digital Input Adapters #3262 (DI), installed within a specific unit, the installation sequence of the feature groups will be:</p> <ol style="list-style-type: none"> <li>1. All Digital Input, Voltage (#3286) groups followed by-</li> <li>2. All Digital Input, Voltage High Speed (#3287) groups followed by-</li> <li>3. All Digital Input, Contact (#3285) groups.</li> </ol>								
<p>For Process Interrupt Adapters #5710 (PI), installed within a specific unit, the installation sequence of the feature groups will be:</p> <ol style="list-style-type: none"> <li>1. All Process Interrupt, Contact (#5715) groups followed by-</li> <li>2. All Process Interrupt, Voltage (#5716) groups.</li> </ol>						<p>For Pulse Counter Adapters #5861 (PCA), installed within a specific unit, the installation sequence for the counters will be:</p> <ol style="list-style-type: none"> <li>1. All Pulse Counter, 16-Bit (#5867) followed by-</li> <li>2. All Pulse Counter 8-Bit (#5862)</li> </ol>								
						<b>A5</b> Group 2 of 1st DO	<b>B5</b> Group 0 of 2nd DO	<b>C5</b> Group 6 of 3rd DI	<b>D5</b> 1st, 2nd, 3rd PCA or Group 0 of 4th DO or 3rd DI or Group 1 of 1st/2nd PI	<b>E5</b> Group 2 of 2nd DI	<b>F5</b> Group 4 of 1st DI	<b>A5</b> Group 4 of 1st DI	<b>B5</b> Group 2 of 2nd DI or 1st/2nd DO	<b>C5</b> 1st/2nd PCA
						<b>A6</b> Group 3 of 1st DO	<b>B6</b> Group 1 of 2nd DO	<b>C6</b> Group 7 of 3rd DI	<b>D6</b> Group 1 of 4th DO or 3rd DI or Group 2 of 1st/2nd PI	<b>E6</b> Group 3 of 2nd DI	<b>F6</b> Group 5 of 1st DI	<b>A6</b> Group 5 of 1st DI	<b>B6</b> Group 3 of 2nd DI or 1st/2nd DO	<b>C6</b> 1st, 2nd or 3rd PCA

required for the groups ordered are installed in the 1801, 1826, or 1827 at the time of delivery. Additional adapters and their corresponding terminal blocks and/or additional terminal blocks added to installed adapters (within the maximum for a specific adapter) can be field installed. The IBM plant of manufacture locates the adapters and groups and specifies the location and computer address of each terminal block.

#### PERSONNEL SAFETY CONSIDERATIONS

Voltages as supplied to digital I/O standard features that conform to operating specifications do not normally present a safety hazard to servicing and installation personnel. However, some cautions should be pointed out.

Under some fault conditions, or with installation of some RPQ's, or with equipment installed by Letter of Alteration and Attachment, hazardous voltages may be present on I/O cables, terminals, or circuits.

IBM considers a shock hazard to exist with any potential above 24 volts ac or dc unless the impedance of its source limits the current flowing through a 1500 ohm non-inductive resistance to 5 ma or less. For potentials above 125 volts, the resistance is reduced to 500 ohms.

It is recommended that customer installed voltages provide a means of disconnecting individual input sources for personnel safety when the circuits are serviced.

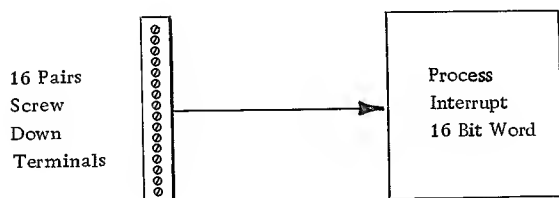
#### DANGER

Do not disconnect the 1800 system's power plug from the primary power receptacle until all powered input lines from customer sources have been disconnected. Otherwise, the system just disconnected may be floating at the voltage potential of customer's input lines.

#### DIGITAL INPUTS

Digital inputs are brought into the system in 16-bit groups. Any format may be used. The three types of digital input and their general specifications are:

##### Process Interrupt



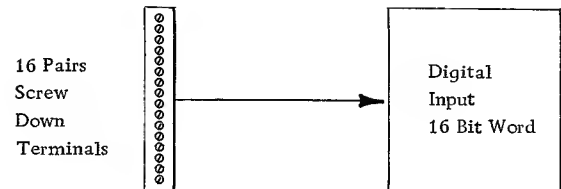
1. Contact Closure: Closed = "1"  
Open = "0"

or

2. Voltage Sense: -1 v to +30 v = "1"  
-6 v to -30 v = "0"

Process interrupt is used for conditions requiring external forced modification of processor action.

##### Digital Input



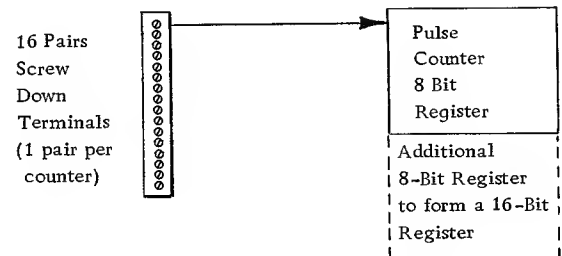
1. Contact Closure: Closed = "1"  
Open = "0"

or

2. Voltage Sense: -1 v to +30 v = "1"  
-6 v to -30 v = "0"

Digital inputs, contact or voltage, are used for sensing the on-off status of various devices. Maximum speed: 500,000 words/second.

##### Pulse Counter



The counter is actuated by voltage pulses:

- Up = -1 v to +30 v  
Down = -6 v to -30 v

The positive leading edge of a pulse indicates a count. Maximum speed: 5,000 pulses per second.

##### Process Interrupt

Process interrupt may be factory wired into any one of 24 priority levels of processor interrupt. When an interrupting condition occurs, the processor program will branch to an interrupt programming

2. Transmission Path: Line lengths and resistance may be of any magnitude as long as the dc voltage levels appear within tolerance at the customer terminals.
3. Interrupt Condition: An interrupt will occur by a voltage level changing from "0" to "1". Interrupt is initiated on the leading edge of the voltage rise:  
Binary "1" = -1.0 vdc min to +30 max  
Binary "0" = -6.0 vdc min to -30 min  
Indeterminate = -6 vdc to -1.0 vdc
4. Input Impedance: 3.7k ohms (approximate)
5. Sensing Delay: Filter and line capacitances introduce a delay before the system can reliably detect a change in voltage level. The following maximum delay values are for line lengths up to 250 feet. The capacitance of longer line lengths will increase the delay.

Delay following a voltage level input and reliable detection: 2.5 ms maximum.  
Delay from maximum signal level, binary "1" until detection of binary "0": 5 ms maximum.

6. Safety Protection: The equipment will tolerate accidental connection to voltage as high as 120 vac without damage other than the possible opening of the fuse in the dc ground line.
7. Electrical Noise Protection: The voltage source should be referenced only to the 1800 system ground through the common or dc return lead of the signal wiring. If desired, a single power supply may be used for more than one input when located in the same immediate area.
8. Terminal Description: Figure 13.
9. Circuit Description: Figure 21.

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routine associated with that level. If a higher level of interrupt is in progress, the new condition waits until the higher one is completed. Interrogation by the interrupt routine will identify the causing condition and initiate action accordingly.

Each pair of customer terminals is selected by the customer to be factory wired to a particular bit position of a 16-bit Process Interrupt Status Word (PISW). Groups of 4 pairs of terminals are factory wired to corresponding bit positions of one or more (up to four) PISWs for each 16 pairs of terminals. Each PISW is interrogated as a 16-bit word for individual terminal identification by digital input programming with addresses 2 to 25 (24 PISWs maximum).

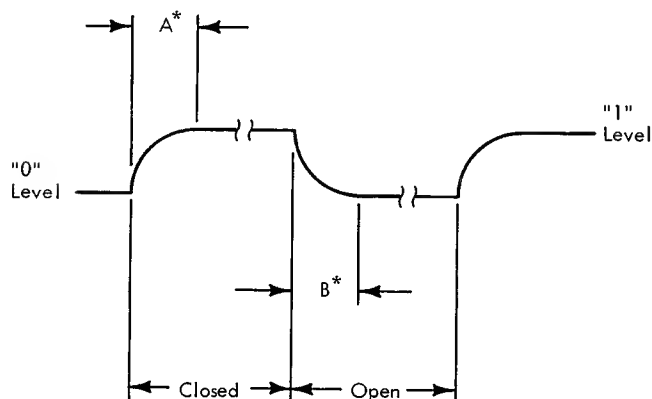
Each PISW is wired by IBM as a group to a customer selected single bit position of an Interrupt Level Status Word (ILSW) associated with a given interrupt level. Twelve (12) levels of interrupt are basic in the 1800 system and twelve additional levels (2 groups of 6 each) are available as special features. A total of 384 process interrupts can be ordered; i.e., 16 interrupts per group (24 groups maximum). Each group of 16 may be either voltage or contact closure input.

To accomplish correct factory wiring of interrupts to the customer's application requirements, a Process Interrupt Assignment Form and an Interrupt Level Assignment Form must be completed and delivered to the plant location where the equipment was ordered within three months from the placement of the original order.

#### Process Interrupt Contact Closure Specifications

1. Contact Grouping: 16 contacts per group (may be individually located).
2. Isolation: Isolated contacts are required; i.e., neither side can be grounded or tied to a voltage supplied by the customer.
3. Interrupt Condition:  
Closed contact - Interrupt condition (interrupt generated on closure)  
Open contact - No action
4. Sensing Voltage: +36 vdc supplied by IBM.
5. Maximum Total Loop Resistance (closed contact): Measured from IBM terminal to IBM terminal - 1000 ohms.
6. Minimum Open Circuit Resistance (open contact): Measured line to line, or line to ground - 50,000 ohms.
7. Closed Circuit Current: 10 ma (approximate).
8. Maximum Shunt Capacitance: 0.5  $\mu$ f - measured line to line).

9. Maximum Series Inductance: 10 millihenries - (measured as total of loop including suppression, if used).
10. Noise Level: 1 volt peak maximum for either contact open or closed (noise voltage measured at customer terminals with transmission line connected).
11. Contact Closure Time: (including transmission line as specified above).



- A\* = Time from contact closure to valid output recognition as an interrupt; 4 ms max, 2 ms min.  
B\* = Time from contact opening to valid output recognizing end of interrupt condition before another contact closure can occur; 10 ms max, 2 ms min.

\* Includes filter time constants for filtering of noise transients but does not include contact bounce. Maximum figures include maximum customer circuit resistance, capacitance, and inductance.

20618

12. Safety Protection: The equipment will tolerate accidental connection to voltage as high as 120 vac maximum without damage other than the possible opening of the fuse in the +36 v line.
13. Terminal Description: See Figure 13.
14. Circuit Description: See Figure 20.
15. Wiring Practice: Twisted pair wiring is recommended for each individual contact. Two wire screw-down termination is provided for each contact. Terminal sizes are #8, on standard barrier strip type terminals. No tie-down for shielding is provided. It is recommended that the customer provide reasonable physical separation between output and analog system wiring, and ac power lines.

#### Process Interrupt Voltage Sense Specifications

1. Contact Grouping: 16 voltage inputs per group (may be individually located)



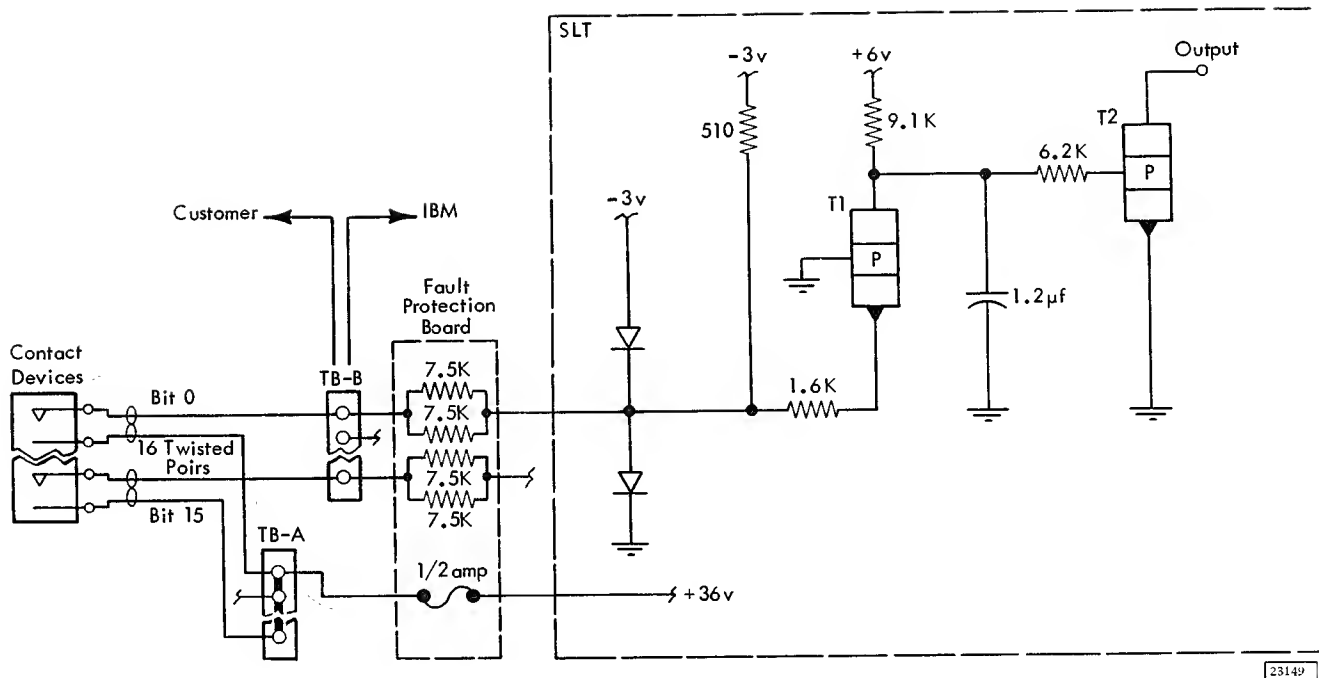


Figure 20. Process Interrupt and Digital Input, Contact Closure Schematic (simplified)

10. Wiring Practice: Twisted pair wiring is recommended for each individual voltage source. Two wire termination is provided for each source. Terminal sizes are #8, on standard barrier strip type terminals. No tiedown for shielding is provided. It is recommended that the customer provide reasonable physical separation from output and analog system wiring and from any ac power lines enroute.

#### Digital Input

Digital input points may be used either collectively as a 16-bit register input or individually for the sensing of separate process conditions. The input data is read by the processor-controller on command as binary "1" or "0" bits in a 16-bit word. Input data is sensed by a voltage change or the change in status of a contact.

The processor-controller can read individual contacts or voltage inputs into the system at a maximum scan rate of 500,000 16-bit words per second. Repetitive reading of the same group is conditioned by a filter which assists in attenuating input line noise. The filter and line capacities introduce a delay before the status of an input change is reliably sensed.

If the high speed option is ordered for reading of register inputs, the reading of the same register

can be accomplished at a rate of 100,000 16-bit words per second. No filter is used in this option, thus necessitating the installation of input cabling such that it assures minimum noise.

#### Digital Inputs Contact Closure Specification

1. Contact Grouping: 16 contacts per group (may be individually located).
2. Isolation: Isolated contacts are required; i.e., neither side can be grounded or tied to a voltage supplied by the customer.
3. Closure Condition:  
Closed Contact - binary "1"  
Open Contact - binary "0"
4. Sensing Voltage: +36 vdc supplied by IBM.
5. Maximum Total Loop Resistance (closed contact): Measured from IBM terminal - 1,000 ohms.
6. Minimum Open Circuit Resistance (open contact): Measured line to line, or line to ground - 50,000 ohms.
7. Closed Circuit Current: 10 ma (approximate).
8. Maximum Shunt Capacitance: Measured line to line 0.5 µf.
9. Maximum Series Inductance: Measured as total of loop including suppression, if used - 10 millihenries.

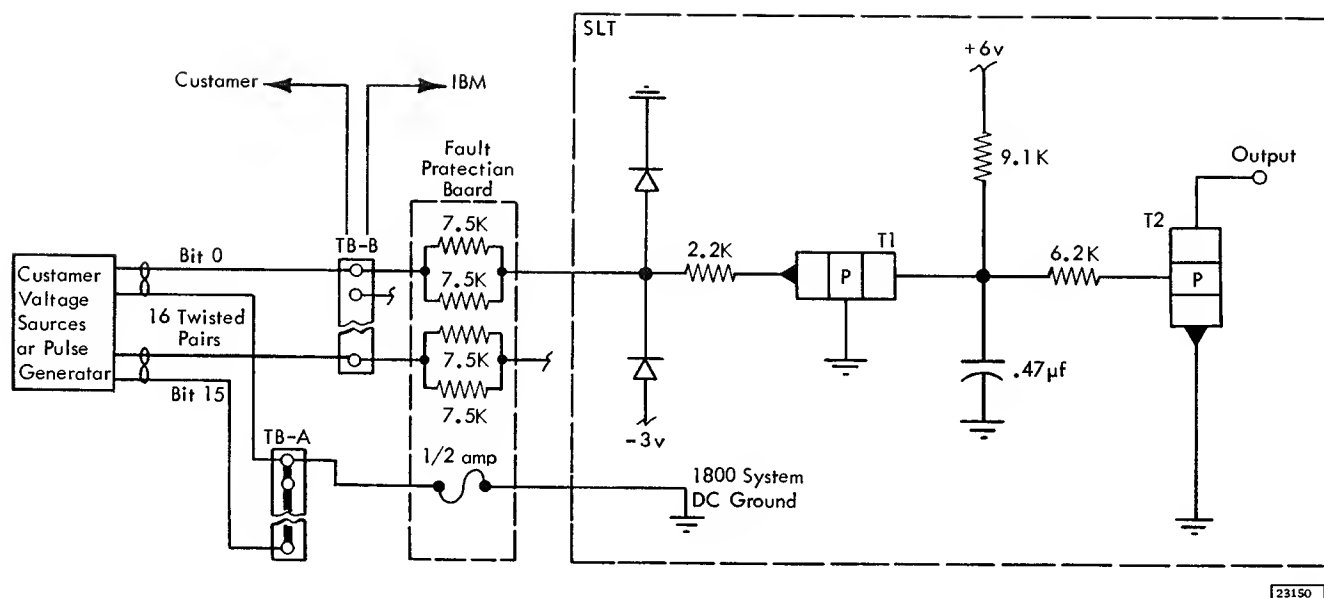
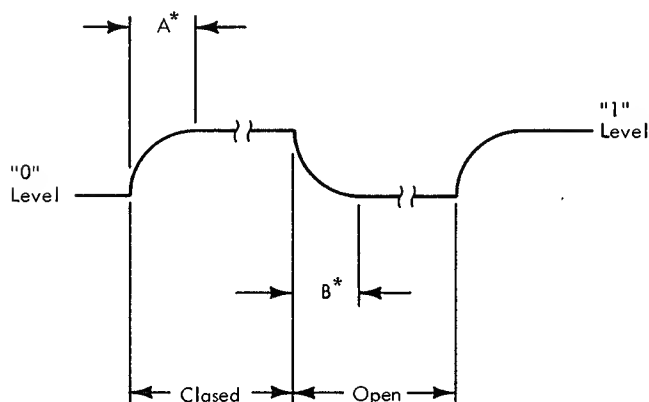


Figure 21. Process Interrupt, Voltage Sense Schematic (simplified)

10. **Noise Level:** 1 volt peak maximum for either contact open or closed (noise voltage measured at customer terminals with transmission line connected).
11. **Contact Closure Time:** (including transmission line as specified above).
12. **Safety Protection:** The equipment will tolerate accidental connection to voltages as high as 120 vac maximum without damage other than the possible opening of the fuse in the +36 v line.
13. **Terminal Description:** See Figure 13.
14. **Circuit Description:** See Figure 20.
15. **Wiring Practice:** Twisted pair wiring is recommended for each individual contact. Two wire screw-down termination is provided for each contact. Terminal sizes are #8 on standard barrier strip type terminals. No tiedown for shielding is provided. IBM recommends that the customer provide reasonable physical separation from output and analog system wiring and from any ac power line enroute.



A\* = Time from contact closure to valid output that can be program sensed as a "1"; 4 ms max, 2 ms min.  
 B\* = Time from contact opening to valid output that can be program sensed as a "0"; 10 ms max, 2 ms min.

\* Includes filter time constants for filtering of noise transients but does not include contact bounce. Maximum figures include maximum customer circuit resistance, capacitance, and inductance.

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#### Digital Inputs Voltage Sense Specification

1. **Contact Grouping:** 16 voltage inputs per group (may be individually located). For the high speed sensing of a 16-bit register, the high speed option may be ordered.
2. **Transmission Path:** Line lengths and resistance may be of any magnitude as long as the dc voltage levels appear within tolerances at the customer terminals. For the high speed

option, the capacitance of line lengths over 100 feet will reduce the maximum rate of data transfer.

3. Voltage Sense Status:

Binary "1" = -1.0 vdc minimum to +30 vdc maximum.

Binary "0" = -6.0 vdc minimum to -30 vdc maximum.

Indeterminate = -6 vdc to -1.0 vdc.

4. Input Impedance: 3.7k ohms (approximate).

5. Sensing Delay: Filter and line capacitances introduce a delay before the system can reliably detect a change in voltage level. The following specified maximum delay values are for line lengths up to 250 feet. The capacitance of longer line lengths increase the delay.

Delay following a voltage level input and reliable detection: 2.5 ms maximum.

Delay from maximum signal level ("1") until detection of binary "0": 5 ms maximum.

High Speed Option: With the high speed option, the filter is removed and the rate may be as high as 100,000 words (16-bits) per second for line lengths up to 100 feet. Longer line lengths will reduce this speed.

Sample rate: 100 kc

Switching delay (circuit response time): 2  $\mu$ s

6. Safety Protection: The equipment will tolerate accidental connection to voltage as high as 120 vac without damage other than the possible opening of the fuse in the dc ground line.

7. Electrical Noise Protection: The voltage source should be referenced only to the 1800 system ground through the common or dc return lead of the signal wiring. A single power supply may be used for more than one input if desired when they are in the same area.

8. Terminal Description: See Figure 13.

9. Circuit Description: See Figure 22.

10. Wiring Practice: Twisted pair wiring is recommended for each individual voltage source. Two wire termination is provided for each source. Terminal sizes are #8, on standard barrier strip type terminals. No tiedown for shielding is provided. It is recommended that the customer provide

reasonable physical separation from output and analog system wiring and from any ac power lines enroute.

When the high speed option is ordered, extra care should be exercised in providing isolated routing for cables. It may be advisable to use shielded twisted pair cables where physical separation of wiring is difficult to attain.

### Pulse Counter Input

The pulse counter feature accepts discrete pulses as input information and advances by one for every received pulse. Two 8-bit or one 16-bit counters are read by the processor-controller as a 16-bit word. Each counter is an 8-bit counting register. A counter is reset on read out by the processor-controller (not on 1827).

Each counter is wired to a single pair of input terminals. A single group of 16 pairs of terminals will accommodate 16 8-bit registers. When counters are ordered as 16-bit registers, the odd numbered terminals remain unused.

### Pulse Counter Input Specification

1. Pulse Rate: 5 kc maximum (for higher rates, request a price quotation from IBM).

2. Transmission Path: Line lengths and resistances may be of any magnitude as long as the voltage levels appear within tolerance at the terminals.

3. Count Status: A count will be recorded on the leading edge of a voltage rise.

Count condition: -1.0 vdc min to +30 max (rise time not critical)

No-count condition: -6.0 vdc min to -30 max

Indeterminate condition: -6.0 vdc to -1.0 vdc

4. Pulse Shape: Squarewave (rise and fall times not critical).

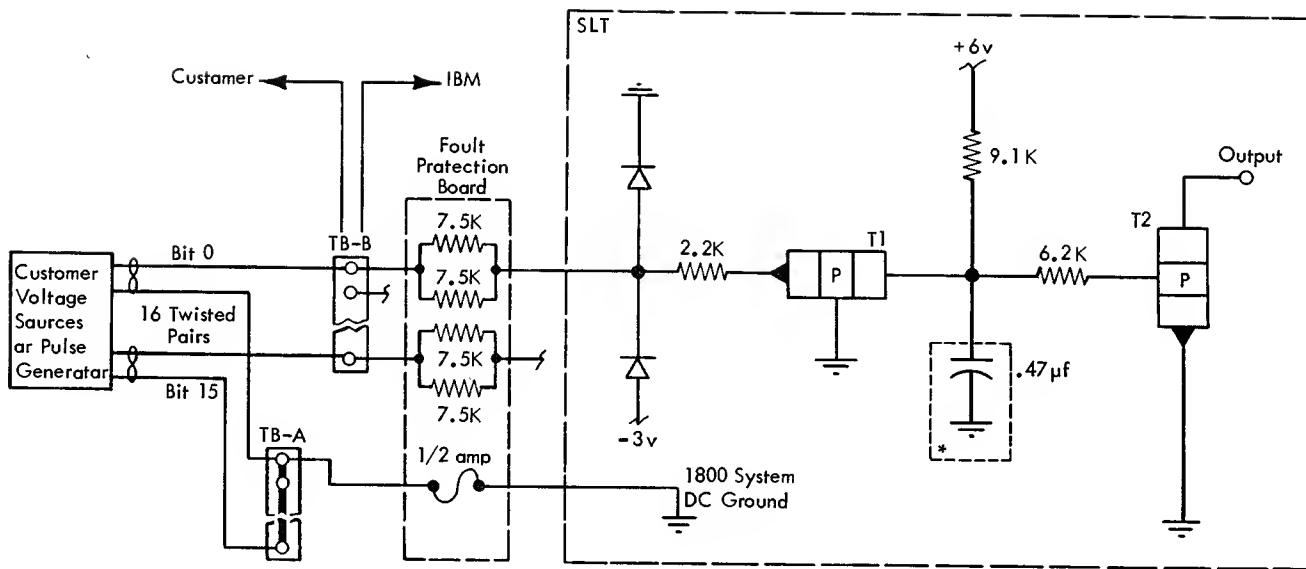
Minimum up time: 100 microseconds

Minimum down time: 100 microseconds

5. Input Impedance: 3.7k ohms (approximate).

6. Safety Protection: The equipment will tolerate accidental connection to voltage as high as 120 vac without damage other than the possible opening of the fuse in the dc ground line.

7. Electrical Noise Protection: The voltage should be referenced only to the 1800 system ground through the common or dc return lead of the



\*Not in circuit for Optional High Speed (#9265)

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Figure 22. Digital Input, Voltage Sense Schematic (simplified)

signal wiring. A single power supply may be used for more than one input if desired when they are located in the immediate area.

8. Terminal Description: See Figure 13.
9. Circuit Description: Figure 23.
10. Wiring Practice: Twisted pair wiring is recommended for each individual count source. Two wire termination is provided for each source. Terminal sizes are #8, on standard barrier strip type terminals. No tiedown for shielding is provided. It is recommended that the customer provide reasonable physical separation from output and analog system wiring and from any ac power lines enroute.

#### External Synchronization

This function is provided by the Digital Input Channel Adapter feature (#3291) and may be used with any digital input feature with the exception of process interrupt.

A "ready" signal is transmitted to the customer's external device. The external device provides a "sync" pulse which causes the processor-controller to initiate reading of a group of input points and removal of the "ready" signal.

Termination for the "ready" and "sync" signals are in the processor-controller. The terminals are illustrated in Figures 12, 15, and 16.

Note: An additional mode of external synchronization may be employed by use of process interrupts. The process-controller may be programmed so that recognition of an interrupt will cause reading of any group of inputs. Feature #3291 is not required in this mode.

#### "Ready" Signal Specification

1. Down Level: -12 volts (through a 1000 ohm resistor)
2. Up Level: 0.0 to -0.5 volts (indicates ready condition)
3. Load Requirements: 50 feet transmission line maximum.
4. Circuit Description: Figure 24.
5. Wiring Practice: Wiring to the "ready" terminals should be accomplished with a single conductor shielded cable. The shielding should be grounded to the 1800 system ground at the terminal provided.

#### "Sync" Signal Specifications

1. Down Level: -6 vdc to -18 vdc
2. Up Level: -0.5 vdc to 0.5 vdc. The data input channel adapter starts on a positive going transition.

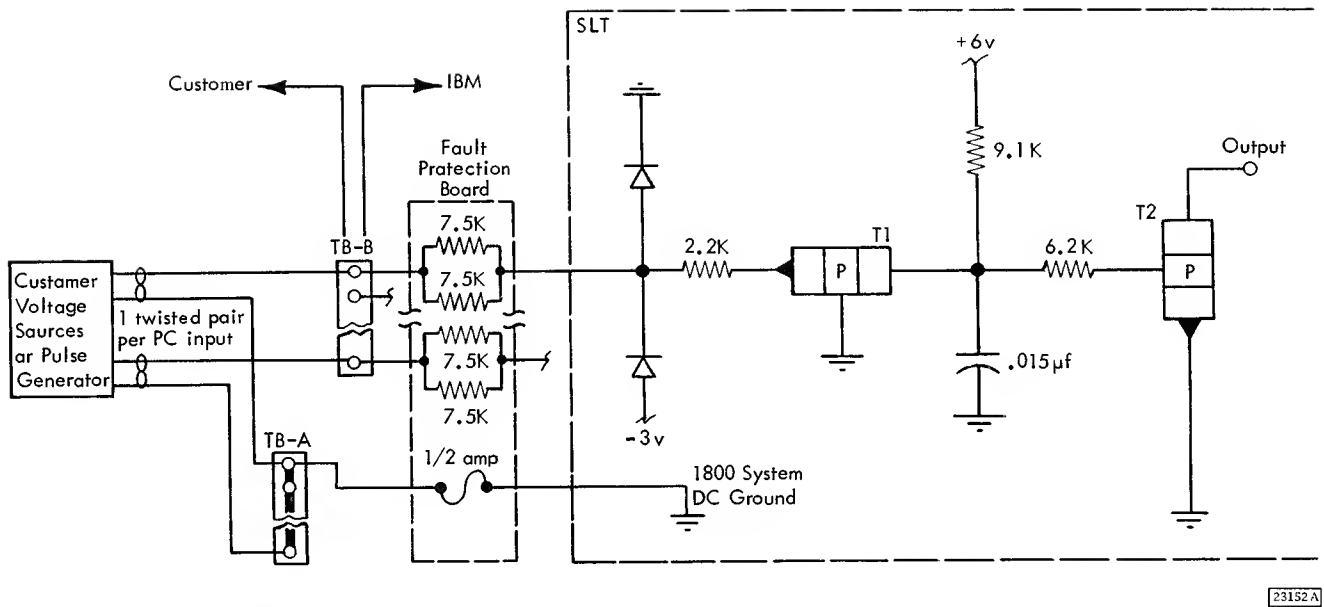


Figure 23. Pulse Counter, Voltage Sense Schematic (simplified)

3. Pulse Shape:

- Minimum up time: 2 microseconds
- Down time: 2 microseconds minimum before next positive transition
- Rise and fall times not critical

4. Loading Requirements: 50-foot transmission line (maximum)

5. Current Requirements: 30 ma maximum

6. Circuit Description: Figure 25.

7. Wiring Practices: Wiring to the "sync" terminals should be accomplished with a single

conductor shielded cable. The shielding should be grounded only to the 1800 system ground at the terminal provided.

## DIGITAL OUTPUTS

Digital outputs in the 1800 are used in groups of 16 bits. Three types are available.

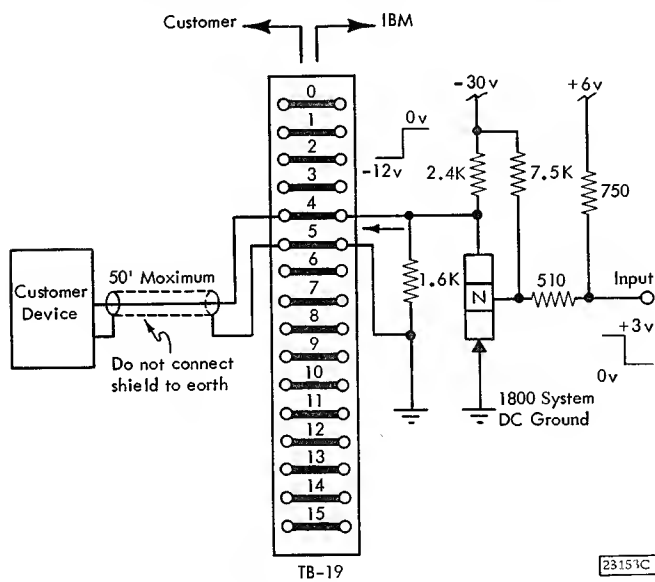


Figure 24. Digital Input "Ready" Signal Terminal and Circuit Schematic (simplified)

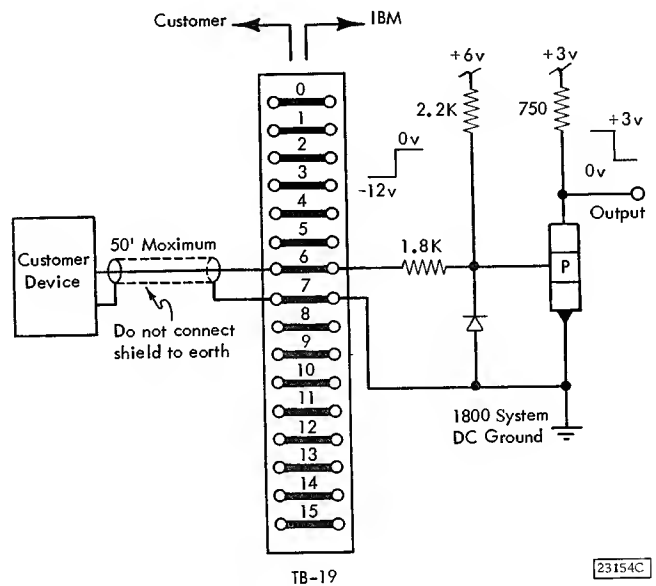
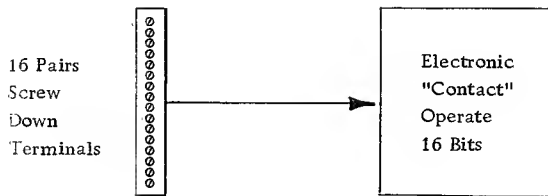


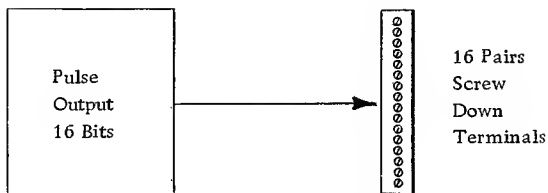
Figure 25. Digital Input "Sync" Signal, Terminal and Circuit Schematic (simplified)

## Electronic "Contact" Operate

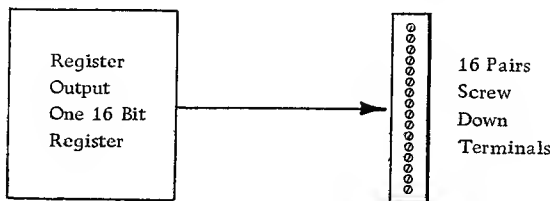


**Latching Output:** 48 vdc at 0.45 amp. Provides ON-OFF control to various devices such as relays, small dc motors, indicator lamps, alarms, and other digital devices.

**Pulse Output:** Provides pulse trains to operate set point positioners and other stepping motor devices (3 ms minimum pulse to 48 vdc at 0.45 amp).



**Register Output:** Provides 16-bit binary information to various devices such as telemetry, digital positioners, and customer DAC converters.



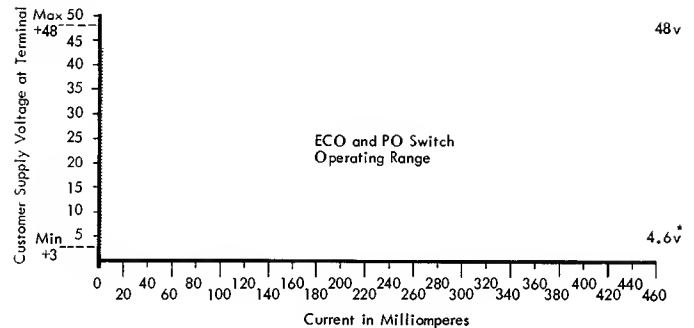
Output: "1" is +3 vdc  
"0" is 0.0 vdc

## Electronic "Contact" Operate

Provides program selection of one or more output points (within a group of 16), permitting the closing of customer circuits for a period of time controlled by the program. The specifications governing the customer's input voltage and load characteristics are:

1. **Ground:** Common or dc return is connected to the 1800 system ground. To avoid ground loops or injection of noise into the system the customer's voltage source should be floating or isolated from ground at the voltage source.
2. **Customer Power Supplies:** Each power supply furnishes power to four (or multiples of four) digital output points (Figure 27).

3. **Load Current (switched):** Must not exceed 0.45 amp.
4. **Voltage:**

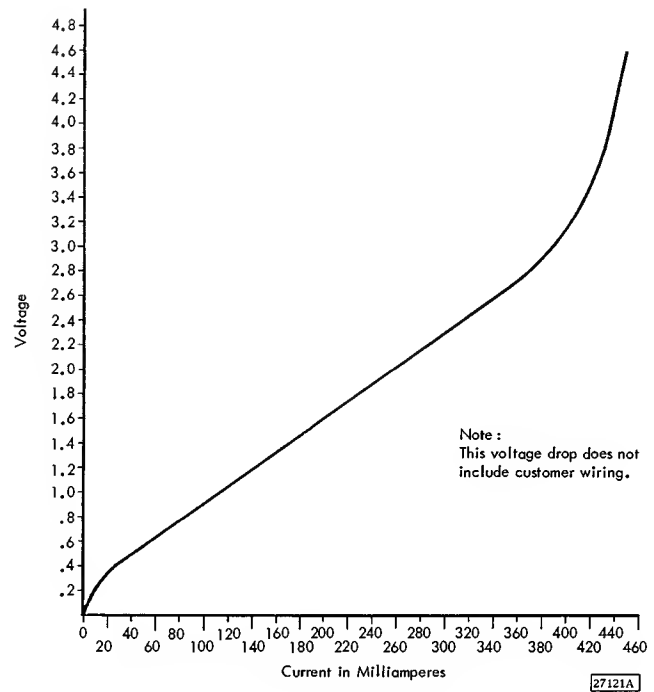


\*See internal voltage drop characteristics Figure.

27120A

## CAUTION

These limits must not be exceeded. AC potentials must not be applied. See Load Characteristics.



27121A

Figure 26. Internal Voltage Drop Characteristics

5. **Load Characteristics:** A wide variety of R, L, and C load characteristics can be accommodated within the above voltage and current specifications provided the peak instantaneous voltage at the terminals does not exceed:  
+65 vdc maximum, 0 vdc minimum (must not be negative)

Where ECO outputs are used to energize switching inductive loads, the switching contacts must have suitable arc suppression. Opening these contacts under load will induce RF AC voltage in the coil controlling the contacts, thus placing AC voltage on the ECO output.

6. Output Impedance:

- Diode - "1" (on) = 5-7 ohms
- "0" (off) = 8.0 ohms
- Switch - "0" (off) = 1.25 megohms
- "1" (on) = plot from Figure 26

7. Transfer Time (resistive load):

- Less than 10  $\mu$ sec for turn on.
- Less than 10  $\mu$ sec for turn off.

8. Duration of Closure: Duration selected by program.

9. Synchronization: Generation of program action may be initiated by an external "sync" signal. See External Synchronization information located in this section of the manual.

10. Terminal Description: ECO may be terminated in the customer access area at the rear of the 1801, 1826, or 1827 units. The location is dependent on the number and variety of digital I/O features which have been ordered. The location of a specific group of terminals will be designated by IBM. Figure 13 illustrates the customer terminations.
11. Circuit Description: Figure 27.
12. Wiring Practice: Use twisted pair wiring to reduce electrical interference. The electronic "Contact" operate wiring should not be run in the same cable with analog or digital inputs.

### Pulse Outputs

The programmed selection of one or more output points within a group of 16 permits the generation of a 3 ms pulse (or pulse chain) to occur simultaneously on the selected points. The specifications governing the customer's input voltage, load characteristics, and wiring practice are identical with electronic contact operate.

### Register Outputs

The Register Output is a 16-bit binary register which can transmit its content over 16 pairs of conductors to a customer provided device. Transfer of this data is under program control and can be initiated by the customer device (either an external "sync" signal, or process interrupt).

The voltage and current specifications are:

1. Rate: 500,000 16-bit words per second (maximum when free-running).

2. Output Voltage:

- binary "1" = +2.5 v to +3.4 v
- binary "0" = 0 v to +1.4 v

3. Output Current: 32 ma maximum (including termination and customer load).
4. Load Characteristic: Termination to customer +3 v and load must present 100 ohms characteristic to the transmission line. Customer +3 v must be between +2.88 and +3.4 v referenced to 1800 system dc ground.
5. Terminal Description: Register outputs terminate in a customer access area at the rear of the 1801 or 1826 units. The location is dependent on the number of variety of digital I/O features which have been ordered. The location of a specific group of terminals will be designated by IBM. Customer terminals are illustrated in Figure 13.
6. Circuit Description: Figure 28.
7. Line Length: 100 feet (maximum).
8. Line Capacitance: 18 picofarads/foot (maximum).
9. Wiring Practice: Use twisted pair conductors for wiring to the terminals in order to minimize pickup of electrical noise. This cable should not be run in the same cable with analog or digital inputs.

### External Synchronization

This function is provided by the Digital Analog Output Data Channel Adapter feature (#3290). This feature adapts digital and analog outputs to a processor-controller data channel to enable output in the cycle stealing mode of operation.

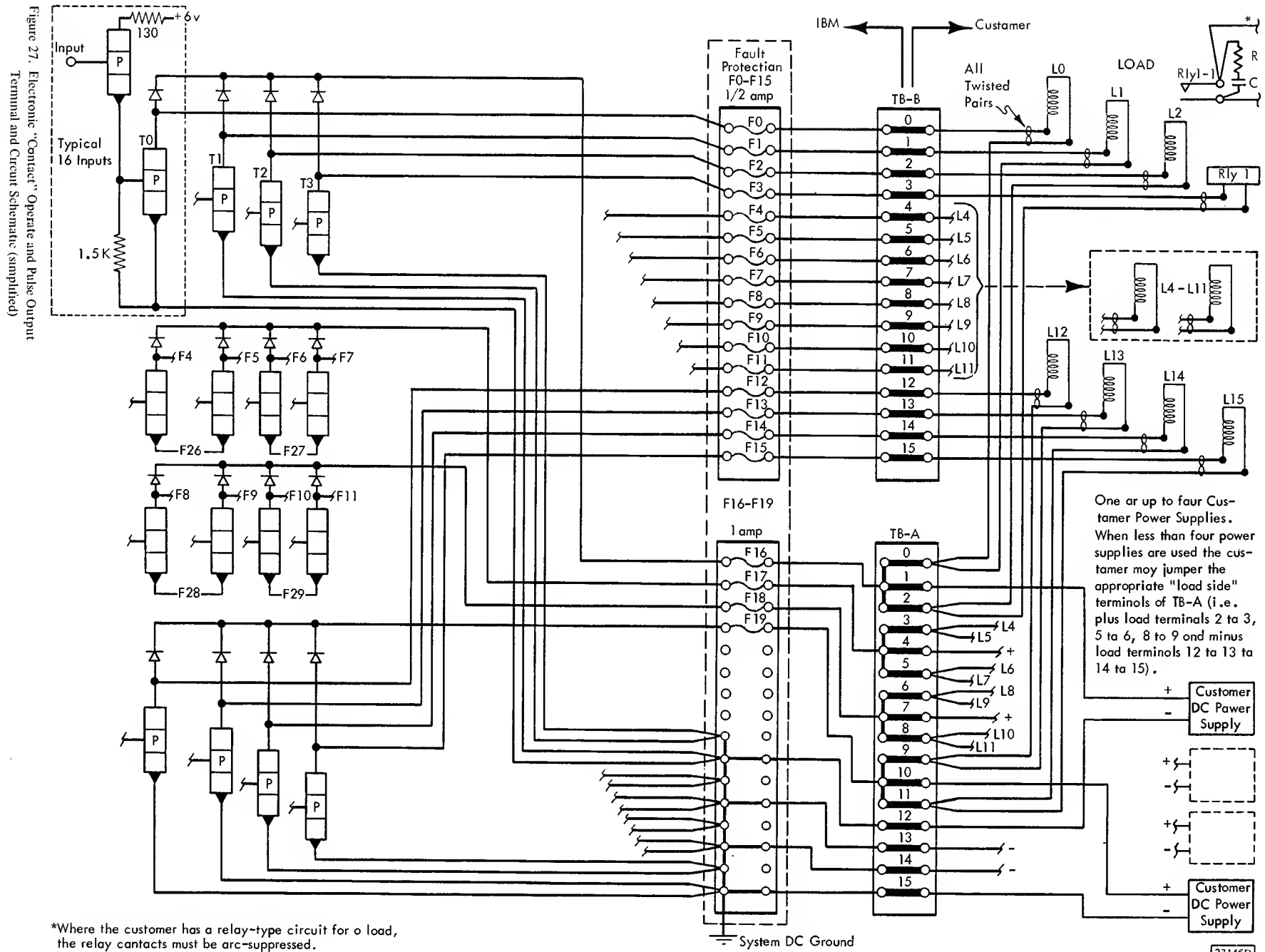
A "ready" signal is transmitted to the customer's external device. The external device provides a "sync" pulse which causes the P-C to initiate action on an output point and removal of the "ready" signal.

Terminations for the "ready" and "sync" signals are in the processor-controller.

Note: An additional mode of external synchronization may be employed by use of process interrupts. The P-C may be programmed so that recognition of an interrupt will cause action on any output point. In this mode feature #3290 is not required.

### "Ready" Signal Specifications

1. Down Level: -12 volts (through a 1000 ohm resistor).
2. Up Level: +0.0 to -0.5 volts (indicates ready condition).





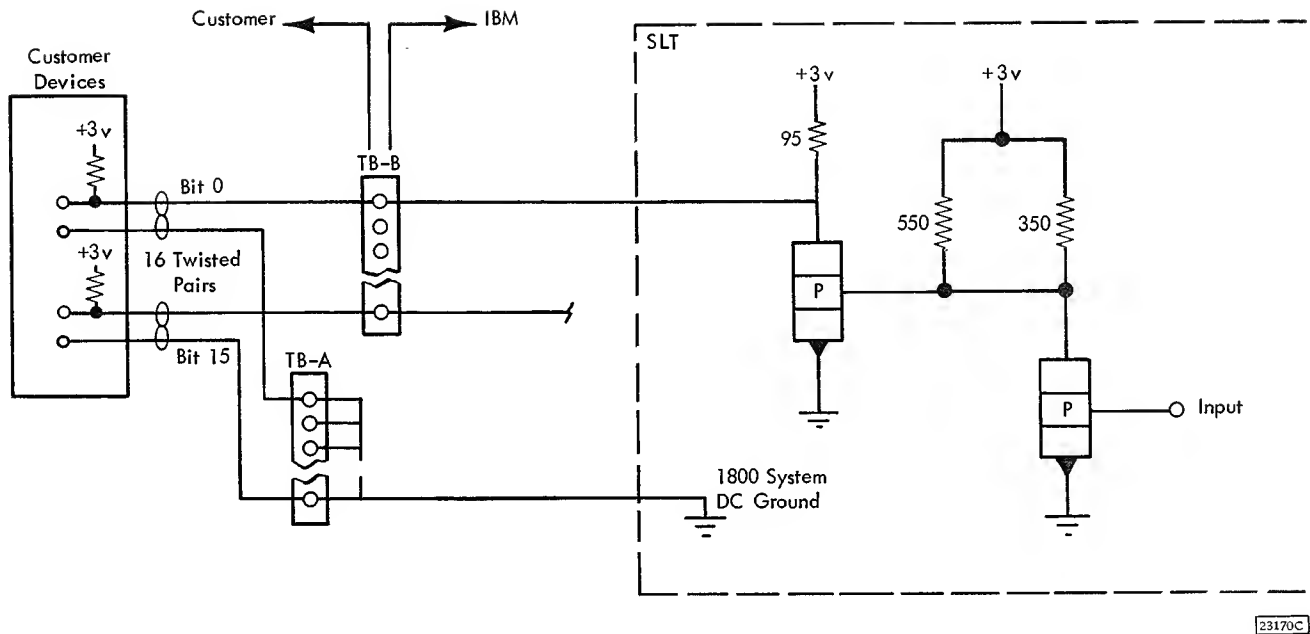


Figure 28. Register Output Terminal and Circuit Schematic (simplified)

3. Load Requirements: 50 foot transmission line maximum.
4. Terminal and Circuit Description: Figure 29.

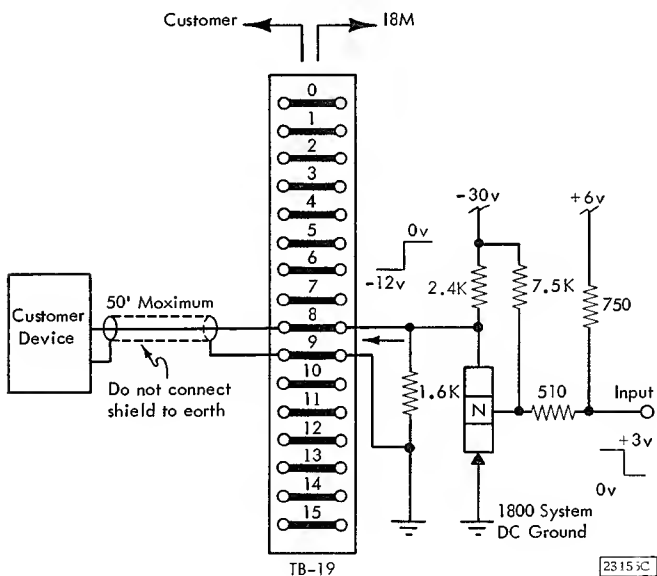


Figure 29. Digital and Analog Output "Ready" Signal, Terminal and Circuit Schematic (simplified)

5. Wiring Practice: A single conductor shielded cable should be used for wiring to the "ready" terminals. The shielding should be grounded to the system ground at the terminal provided.

#### "Sync" Signal Specifications

1. Up Level: -0.5 vdc to +0.5 vdc. The data channel adapter starts on a positive going transition.
2. Down Level: -6 vdc to -18 vdc.
3. Pulse Shape:  
Minimum up level: 2 microseconds average  
Down level: 2 microseconds minimum before next positive going transition.  
Rise and fall times are not critical.
4. Loading requirements: 50 foot transmission line (maximum).
5. Current Requirements: 30 ma (maximum).
6. Terminal and Circuit Description: Figure 30.
7. Wiring Practice: A single conductor shielded cable should be used for wiring to the "sync" terminals. The shielding should be grounded to the 1800 system ground at the terminal provided.

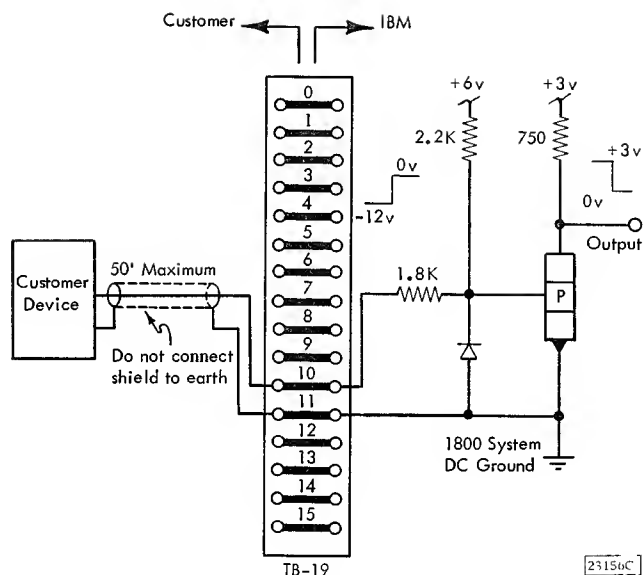


Figure 30. Digital and Analog Output "Sync" Signal, Terminal and Circuit Schematic (simplified)

### IBM 1856 ANALOG OUTPUT TERMINAL

The 1856 Analog Output Terminal provides power and housing for analog output features of the 1800 system. The terminal is designed for mounting in an 1828 enclosure. The analog output terminal may be located in an 1828 model 2 (abutted to the 1801, 1802, or 1827) or in the 1828 model 1 or model 2 (located up to 100 feet from the 1801, 1802, or 1827). When mounted in non-abutted enclosures, it is necessary to install cable groups "9" and "8" for power and signal transmission. When abutted to the 1801, 1802, or 1827, the 1856 may be mounted in the same 1828 enclosure as the 1851 multiplexer terminals. When mounted in the same 1828 enclosure, the 1851 shall take precedence over the 1856 in internal cabling proximity to the 1801, 1802, or 1827 because of the more critical signal levels of the 1851.

The customer terminations in the 1856 terminal are illustrated in Figure 31. The Analog Output Terminal Model 1 provides Analog Output Controls, a Power Pac, a Precision Voltage Reference (PVR), and mounting for four Digital-to-Analog Converters (DAC) with optional Analog Driver Amplifiers (ADA). The model 2 is similar, but does not contain analog output controls and must therefore be used in conjunction with the model 1.

### DIGITAL TO ANALOG CONVERTERS (DAC)

There are four special features that provide digital to analog conversion. The characteristics and feature numbers are listed below. Mod 1 and 2 DACs provide characteristics for operating strip chart recorders, oscillographs, and oscilloscopes. Mod 3 and 4 DACs provide characteristics required for use with hybrid systems. See Figure 31 for customer termination locations.

FEATURE	RESOLUTION	NUMBER OF OUTPUT POINTS
Mod 1 (#3251)	10	1
Mod 2 (#3252)	10	2
Mod 3 (#3253)	13	1
Mod 4 (#3254)	13	2

### Specifications

#### 10-Bit DAC Output

Resolution: 10-bit

Voltage range: 0 to 4.995 volts

Output impedance: 10,000 ohms  $\pm 6$  ohms.

Conversion time: Depends on customer load capacitance - 10  $\mu$ sec (to within 10 mv) with less than 60 picofarad load

Quantity of outputs per DAC: Mod 1 - 1  
Mod 2 - 2 (Mod 2 provides two independent Digital to Analog Converters in one housing)

Circuit description: Figure 32.

#### 13-Bit DAC Output

Resolution: 13-bit

Voltage range: 0 to 4.9994 volts or 0 to - 5.000 v.

Output impedance: 10,000 ohms  $\pm 6$  ohms.

Conversion time: Depends on customer load capacitance - 10  $\mu$ sec (to within 10 mv) with less than 60 picofarad load.

Quantity of outputs per DAC: Mod 3 - 1  
Mod 4 - 2 (Mod 4 provides two independent Digital to Analog Converters in one housing)

Circuit description: See Figure 33.

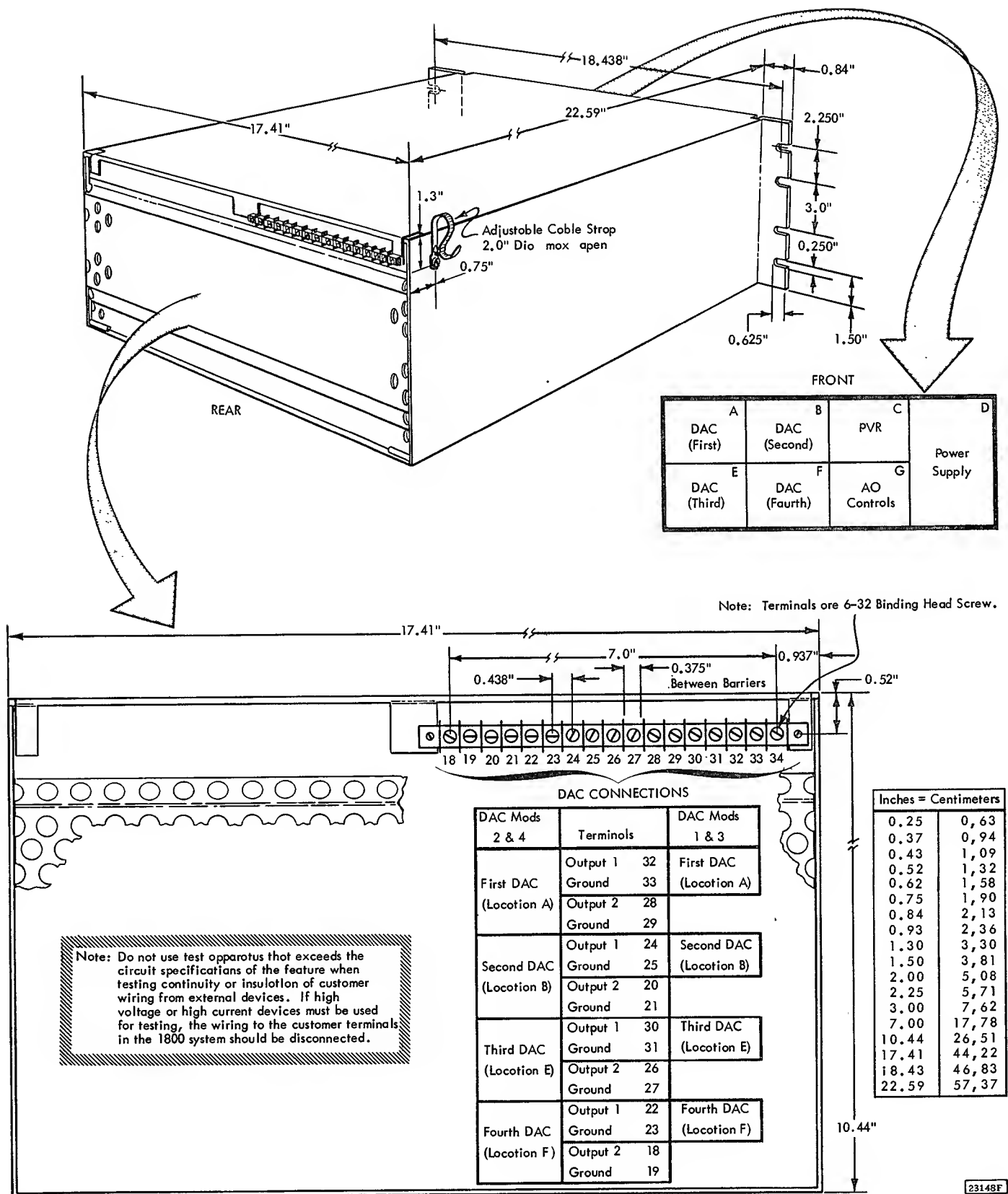
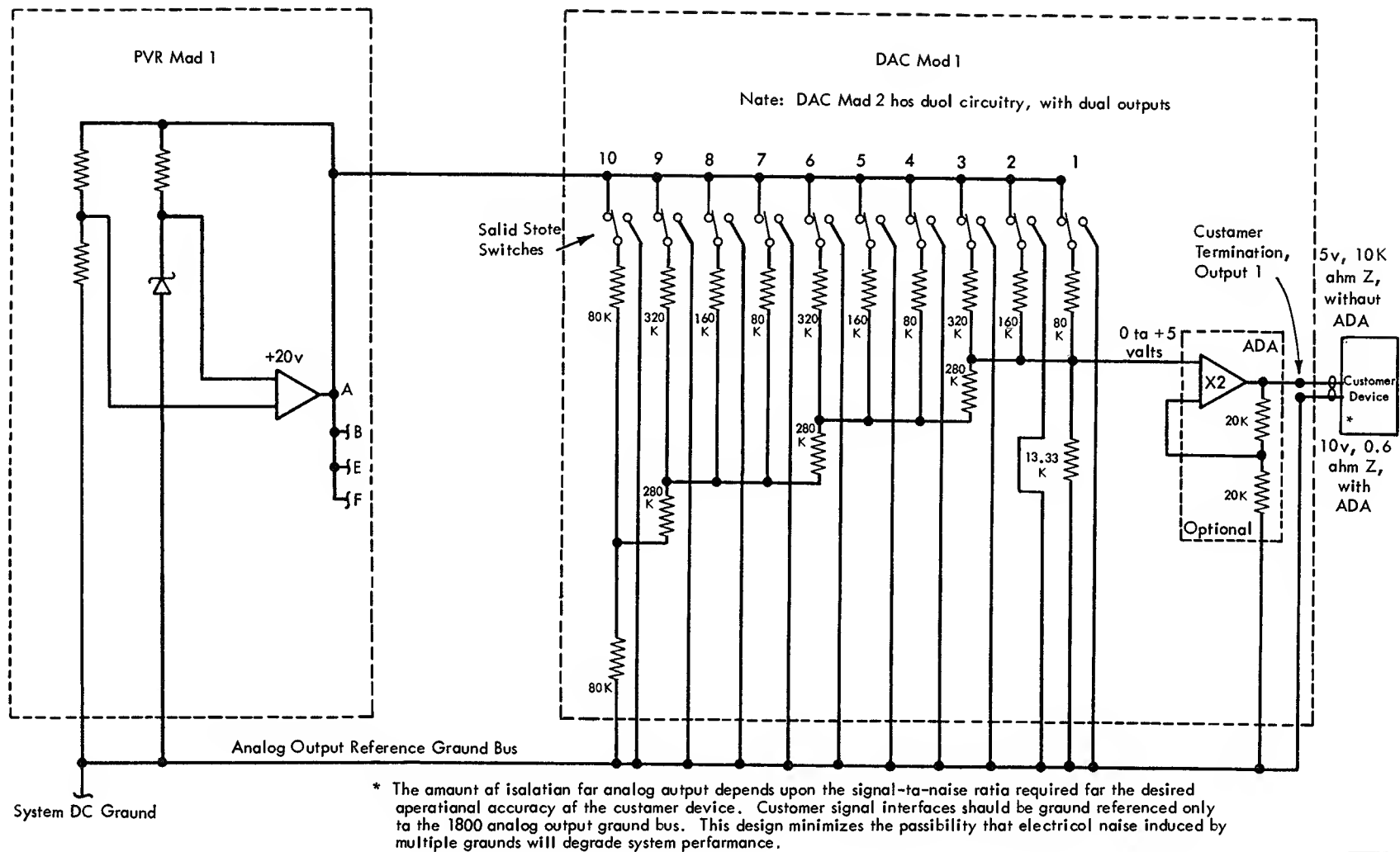


Figure 31. 1856 Customer Terminations

Figure 32. PVR and 10-Bit Analog Output Simplified Diagram





## ANALOG DRIVER AMPLIFIER (ADA)

Each ADA provides buffering isolation impedance for one 10-bit or 13-bit analog output point and increases the driving capabilities of analog output channels. The ADA is an optional feature than can be installed within the DAC module. The ADA is a potentiometric single-ended, high gain, wide band, dc operational amplifier with a fixed closed loop gain which provides noninverting amplification.

### Specifications

#### Analog Driver Amplifier

Gain: +2

Full scale output voltage: +9.990V (with 10-bit DAC) or -10.000 to +9.998V (with 13-bit DAC)

Output current: ±10 milliamperes

Output impedance: Less than 0.6 ohm at dc

Maximum capacitive load: 2,000 picofarads

Minimum resistive load: 1,000 ohms

Settling time for full scale input: 10 μsec

(to within 20 mV with 10-bit DAC or to within 10 mV with 13-bit DAC) with maximum capacitive load.

Circuit protection: The output may be shorted indefinitely without damage to components.

Circuit description: See Figures 32 and 33.

## PRECISION VOLTAGE REFERENCE

The Precision Voltage Reference (PVR) provides the precision voltage source required to obtain a voltage output signal from a DAC. The PVR is supplied in two mods.

PVR Mod 1: The Mod 1 provides unipolar 20 volt source required to obtain a voltage output signal from a 10-bit DAC.

PVR Mod 2: The Mod 2 provides bipolar 20 volt source required to obtain a voltage output signal from either a 10-bit or 13-bit DAC.

Design of the PVR permits high output stability against temperature and load changes and incorporates remote load sensing to minimize loss of regulation due to line drop between the PVR and the DAC.

The simplified schematics (Figures 32 and 33) illustrate the PVRs, DACs, and ADAs.

### PVR Specifications

1. Output Voltage: Mod 1 - ±20V, adjustable to +0.003V, -0.007V.  
Mod 2 - Four +20V and one -20V, each adjustable to 19.998 + 0.001V
2. Output voltage variations under load:  
Mod 1 - ±5 mV  
Mod 2 - ±1 mV
3. Output current: Mod 1 - Must absorb a reverse current of 0 to 240 mA.  
Mod 2 - Must absorb a reverse current of 0 to 120 mA on each +20V and each -20V.
4. Temperature Coefficient:  
Mod 1 or Mod 2 - ±.001% per degree C.
5. Six Month Stability:  
Mod 1 - ±5 mV  
Mod 2 - ±2.6 mV

### External Synchronization

This function is provided by the Digital Analog Output Data Channel Adapter feature (#3290). This feature adapts digital and analog outputs to a processor-controller data channel to enable output in the cycle stealing mode of operation.

A "ready" signal is transmitted to the customer's external device. The external device provides a "sync" pulse which causes the P-C to initiate action on an output point and removal of the "ready" signal.

The specifications and terminations are identical to those listed under subheadings of Digital Outputs and Figures 29 and 30.

## ANALOG INPUTS

### IBM 1851 MULTIPLEXER TERMINAL

The 1851 provides termination for analog input signals as well as the housing for signal conditioning

elements, differential amplifiers, and groups of multiplexing switches.

### Models

Model 1 is a standard terminal for all nonthermocouple analog input signals. It provides for terminating up to 64 differential inputs. Customer termination points for the model 1 are shown in Figure 34. Model 2 is a thermocouple terminal for thermocouple and nonthermocouple analog input signals. The customer may terminate up to 62 inputs (Figure 35). The first two input terminations are used for thermocouple reference temperature measurement.

### Features

Differential Amplifier: This is a time share amplifier used to raise each low level signal to the  $\pm 5$  volt level of the ADC. It is used with up to 16 multiplexer/R groups (256 points), in the same or adjacent 1851s located in the same 1828 enclosure, to provide analog amplification and conversion from differential input to single-ended output. Preselected gains of 500, 250, 100, 50, 25, and 10 are available. This provides for amplification of input voltage levels of  $\pm 10$ ,  $\pm 20$ ,  $\pm 50$ ,  $\pm 100$ ,  $\pm 200$ , or  $\pm 500$  millivolts. A maximum of two amplifiers can be installed in any 1851 terminal housing multiplexer/R.

Multiplexer/R: This feature provides relay (R) multiplexing at 100 points per second with high input resistance (greater than 10 megohms at approximately  $77^{\circ}\text{F}$ , or  $25^{\circ}\text{C}$ ), high common mode voltage operation (200 volts), and high common mode rejection. It consists of a group of 16 points for multiplexing of low or high level ( $-0.5$  to  $+5$  volts) differential analog input signals. Low level differential groups must be assigned to a specific differential amplifier. One of six low level input voltage ranges must be specified for the Differential Amplifier (#3246). Each multiplexer/R group must also be specified in one of seven ranges (high level  $+5$  to  $-0.5\text{v}$ , low level  $\pm 10\text{mv}$ ,  $\pm 20\text{mv}$ ,  $\pm 50\text{mv}$ ,  $\pm 100\text{mv}$ ,  $\pm 200\text{mv}$ , or  $\pm 500\text{mv}$ ). The first multiplexer/R groups installed in the 1851 model 2 must include a differential amplifier with gain settings for 10, 20, or 50 millivolts. The model 2 provides only 62 input points since the first two points are used

to read the temperature of the terminals. The maximum repetition rate per point is 50 samples per second (without filtering).

Multiplexer/S: This is a group of 16 points for solid state (S) high speed multiplexing of high level (0 to  $\pm 5$  volts) single-ended analog input signals. A maximum of 256 points are available per ADC.

### Signal Conditioning Elements

The 1851 is designed to sense voltages. Signal conditioning elements are available to convert customer current or voltage signals to a voltage range compatible to the 1851 sensing circuits. These elements are:

Current Element: The current element converts 4 to 20 milliampere signals to either 1 to 5 volt (current/HL) or 0.1 to 0.5 volt signals. The 1 to 5 volt range is used for high level input signals. The 0.1 to 0.5 volt range is used for input signals in the  $\pm 500$  millivolt range. The current element can be installed with either multiplexer/R or multiplexer/S. The current element consists of a precision resistor with crimped ring terminals attached to 1" (2,54cm) leads. The elements are shipped separately to and installed by the customer on the 1851 terminals where his analog signals are connected. The current element may not be used with the voltage element.

Filter Element: The filter element is a low pass, passive filter to reject normal mode ac noise on one analog input point. It provides normal mode 60 cycle rejection ratio of 125 to 1. Sampling rates on a single input point should not exceed three samples per second for optimum system performance. The maximum safe input voltage is  $-0.5$  to  $+6$  volts. This feature may not be installed for use with multiplexer/S.

Voltage Element: The voltage element provides 2 to 1 voltage attenuation with source impedance of 0.1 ohm for one analog input signal (presents 4K load resistance to source for multiplexer/R or 2K load resistance for multiplexer/S). This allows the intermixing of 100-millivolt signals and 50-millivolt signals in the same multiplexer/R group. Attenuation varies with source impedance. Special circuits can be provided by RPQ, or the customer, for specific source impedance.

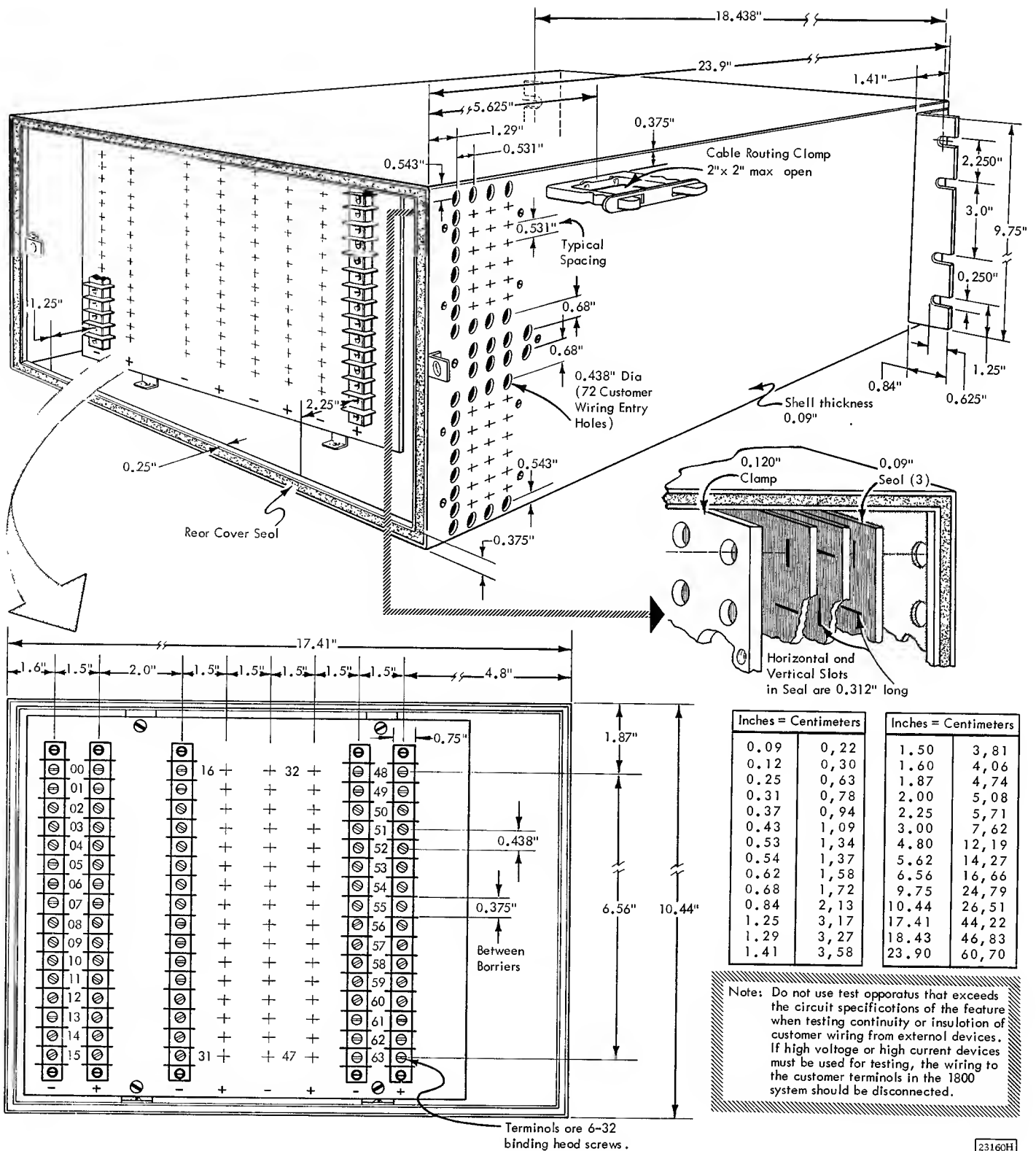


Figure 34. 1851 Multiplexer Terminal Model 1, Customer Terminations



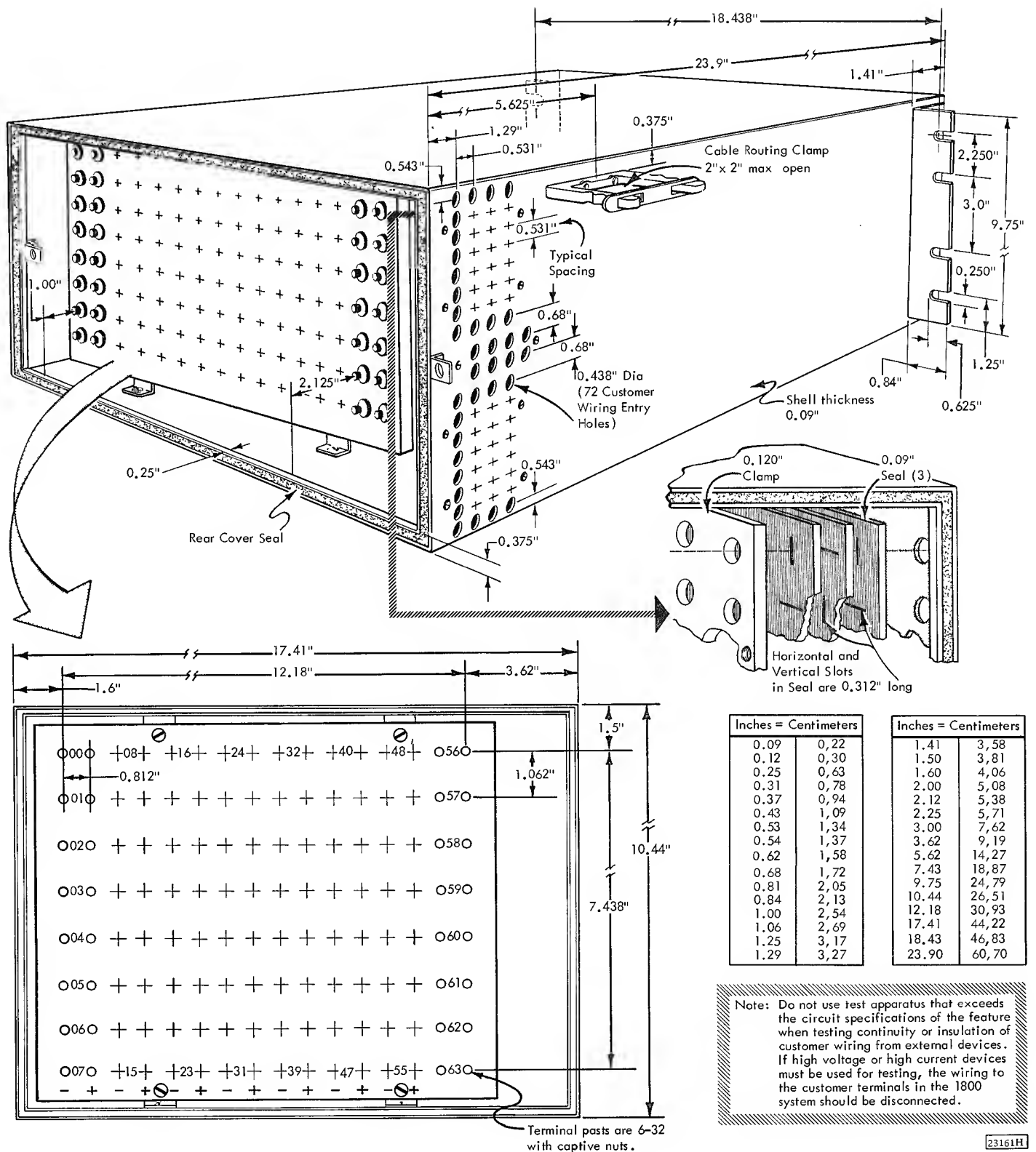
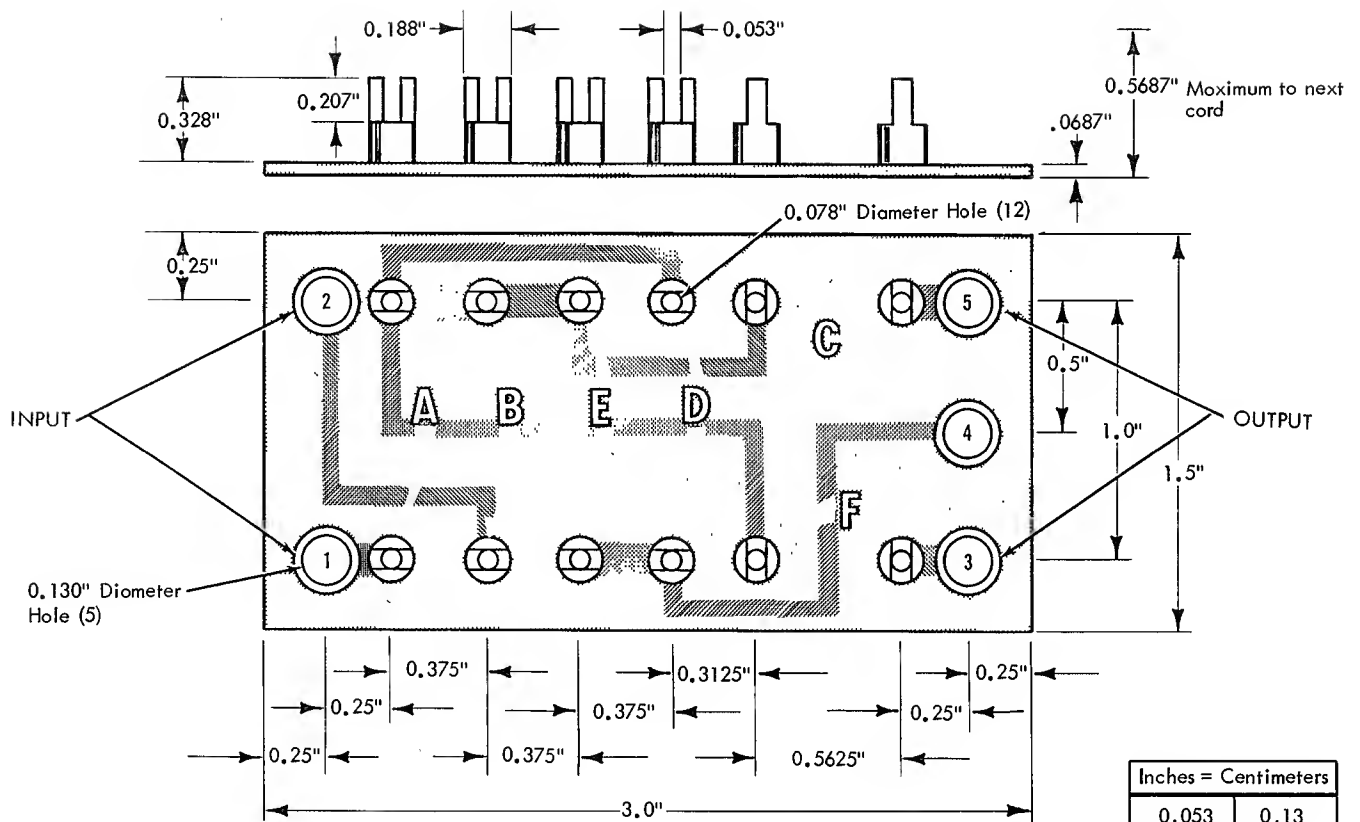
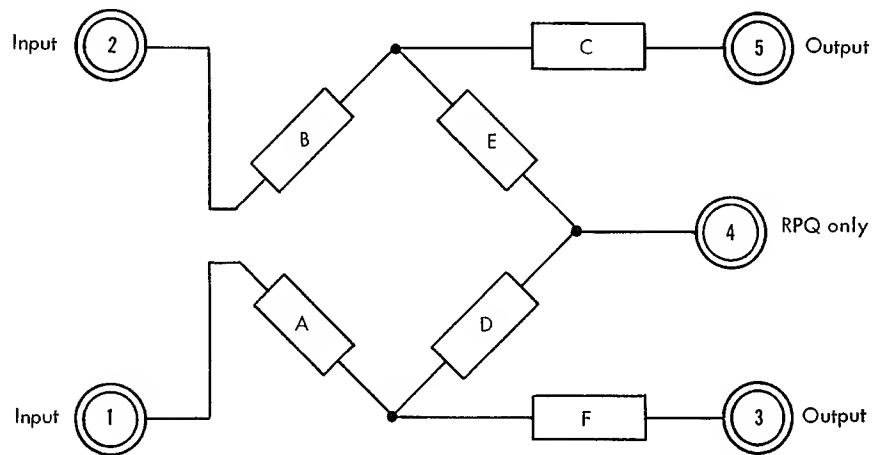


Figure 35. 1851 Multiplexer Terminal Model 2, Customer Isothermal Terminations



Component Schematic



Inches = Centimeters	
0.053	0,13
0.068	0,17
0.078	0,19
0.130	0,33
0.188	0,47
0.207	0,52
0.250	0,63
0.312	0,79
0.328	0,83
0.375	0,95
0.500	1,27
0.562	1,42
0.568	1,44
1.000	2,54
1.500	3,81
3.000	7,62

Note: Component type and values are selected and mounted on the cord by the customer.

23159C

Figure 36. Custom Element and Component Schematic

The voltage element with multiplexer/R provides the filtering function defined under the Filter Element. A filter element cannot be installed on points for which Voltage Elements are ordered.

**Connector Element:** The connector element is wired for straight through connection with no signal conditioning.

**Custom Element for Special Components:** The custom element is available for customer mounting of special conditioning circuits to meet a particular requirement. This card is illustrated in Figure 36. The layout and dimensions will be helpful in designing special circuit networks. The custom elements are installed by the IBM Customer Engineer but remain the customer responsibility.

#### CAUTION

Use noncorrosive flux when mounting components on the custom element.

#### MULTIPLEXER/R SPECIFICATIONS

For input types 1, 2, and 3 (multiplexer/R high level full scale negative input ranges can be accepted if the customer leads are reversed at the terminals.

1. **Input Type:** Floating differential, unfiltered voltage input using IBM Connector Element (Figure 37).  
**Input Impedance:** 10 megohm minimum, 330  $\mu$ f switched capacitive, open input during sampling.  
**Sampling Rate:** 50 samples per second per point maximum, 100 points per second maximum.  
**Input Range:** -0.5 volts to +5.0 volts without differential amplifier. 0 to  $\pm 10$  millivolts, 0 to  $\pm 20$  mv, 0 to  $\pm 50$  mv, 0 to  $\pm 100$  mv, 0 to  $\pm 200$  mv, or 0 to  $\pm 500$  mv with selected differential amplifier.  
**Maximum Overload:** -0.5 volts to +6.0 volts dc or peak ac.  
**Zero Offset:** Adjustable to zero on 10 mv to 500 mv ranges.  
**Source Impedance:** 1000 ohms maximum, 100 ohms minimum without appreciable contribution to error. Consider source resistance error when using higher source impedance. Transmission line resistance must be included in calculation of source impedance and will also reduce the maximum usable sampling rate.  
**Filter Characteristics:** Use source resistance in computing RC time with 330  $\mu$ f for determining input bandwidth. With 100 ohms the

cutoff frequency is 5.0 Hz (-3 db point) and an attenuation of 6 db/octave above this point. Common Mode Voltage: 200 volts maximum operating, 250 volts maximum safe.

**Note:** Use filtered inputs for maximum rejection of noise.

#### DANGER

Where the operating common mode voltage exceeds 48 volts, a disconnect should be provided for personnel safety while servicing the equipment.

2. **Input Type:** Floating differential, filtered voltage input using IBM Filter Element (Figure 37).  
**Input Impedance:** 10 megohms minimum. 330  $\mu$ f switched capacitive, open input during sampling.  
**Sampling Rate:** 3 samples per second per point maximum for best common mode rejection. 100 points per second maximum.  
**Input Range:** -0.5 volts to +5.0 volts without differential amplifier. 0 to  $\pm 10$  millivolts, 0 to  $\pm 20$  mv, 0 to  $\pm 50$  mv, 0 to  $\pm 100$  mv, 0 to  $\pm 200$  mv, or 0 to  $\pm 500$  mv with selected differential amplifier.  
**Maximum Overload:** -0.5 volts to +6.0 volts dc or peak ac.  
**Zero Offset:** Adjustable to zero on 10 mv to 500 mv ranges.  
**Source Impedance:** 1000 ohms maximum without appreciable contribution to error. Consider source resistance error when using higher source impedance. Transmission line resistance must be included in calculation of source impedance and will also reduce the maximum usable sampling rate.  
**Filter Characteristics:** Noise rejection ratio at 60 cps is 125:1 with a source impedance of less than 1 ohm. Time constant is .330 seconds (multiply by 10 for 99.97% stabilized response to signal changes). Add source resistance (including transmission line) for total RC computation of input bandwidth.  
**Common Mode Voltage:** 200 volts maximum operating. 250 volts maximum safe. Common mode rejection is improved by minimizing line unbalance.

#### DANGER

Where the operating common mode voltage exceeds 48 volts, a disconnect should be provided for personnel safety while servicing the equipment.

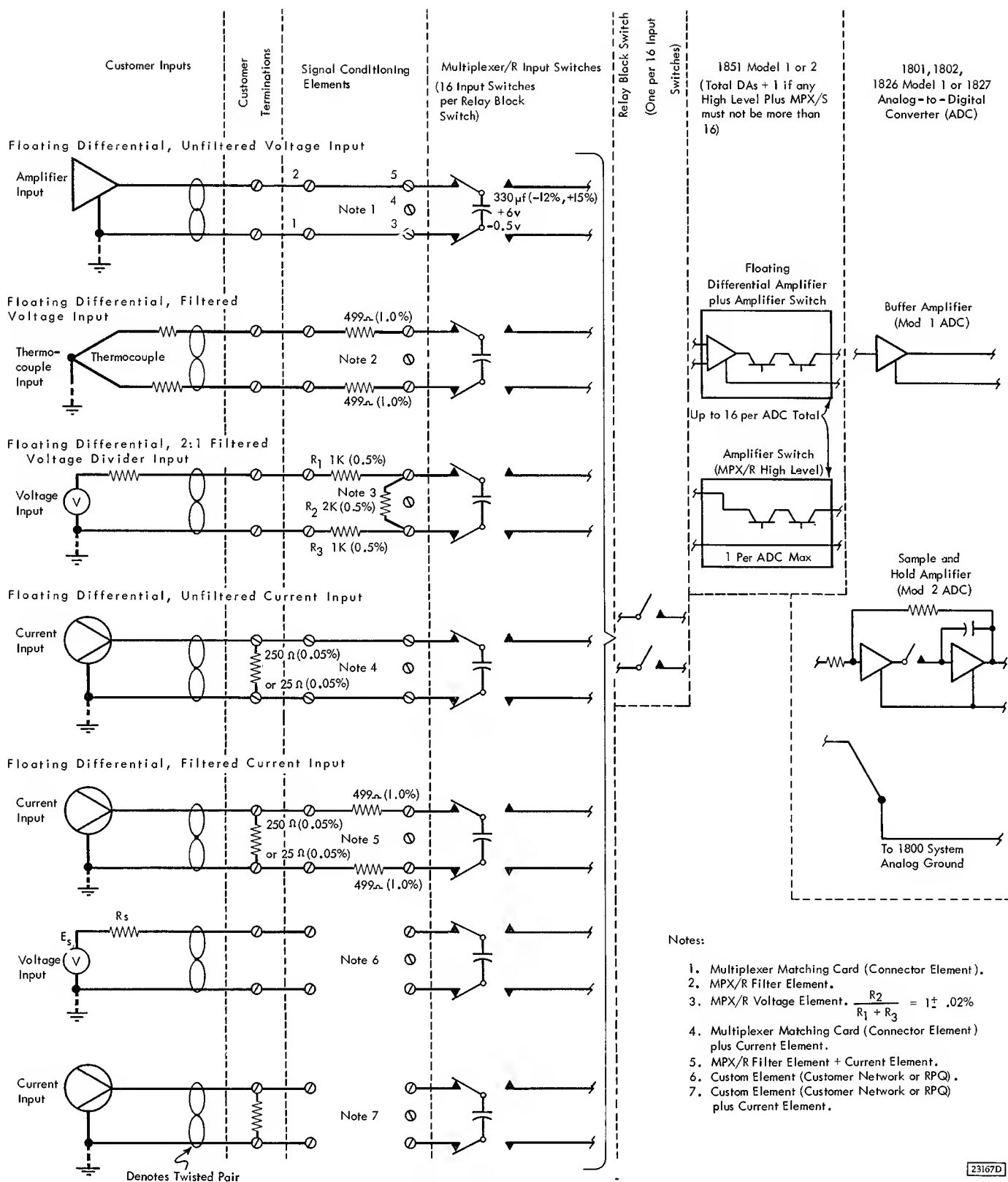


Figure 37. Relay Multiplexer Inputs (MPX/R)

3. Input Type: Floating differential, 2:1 filtered voltage divider input using IBM Voltage Element. (See Figure 37.)  
Input Impedance: 4000 ohms.  
Sampling Rate: 3 samples per second per point. 100 points per second maximum.  
Input Range: -1.0 to +10.0 volts without differential amplifier 0 to  $\pm 20$  millivolts, 0 to  $\pm 40$  mv, 0 to  $\pm 100$  mv, 0 to  $\pm 200$  mv, 0 to  $\pm 400$  mv, or 0 to  $\pm 1.0$  volt with selected differential amplifier.  
Maximum Overload: -1.0 to 12.0 volts dc or peak ac.  
Zero Offset: Adjustable to zero, 10 mv to 500 mv ranges.  
Maximum Source Impedance: 1.0 ohm maximum (including transmission line) without appreciable contribution to error.  
Filter Characteristics: Noise rejection ratio at 60 cps is 125:1. Time constant is .330 seconds (multiply by 10 for 99.97% stabilized response to signal changes). Add source resistance (including transmission line) when computing input bandwidth.  
Common Mode Voltage: 200 volts maximum operating. 250 volts maximum safe.

#### DANGER

When operating common mode voltage exceeds 48 volts, a means of disconnecting this source must be provided for personnel safety.

4. Input Type: Floating differential, unfiltered current input using IBM Connector and Current Elements. (See Figure 37.)  
Input Impedance: 250 ohms without differential amplifier or 25 ohms with differential amplifier set at 0 to  $\pm 500$  millivolt range.  
Sampling Rate: 50 samples per second per point maximum. 100 points per second maximum.  
Noise rejection ratio: 30 to 1 at 60 cps without differential amplifier; 3 to 1 at 60 cps with differential amplifier.  
Input Time Constant: 82.5 milliseconds without differential amplifier; 8.25 milliseconds with differential amplifier.  
Input Range: 40 to 20 ma.  
Maximum Overload: -2 ma to +24 ma.  
Offset: 1 volt to ADC at 4 ma.  
Source Characteristic: High impedance current source.  
Common Mode Voltage: 200 volts maximum operating. 250 volts maximum safe.

#### DANGER

Where operating common mode voltage exceeds 48 volts, a means of disconnecting this source must be provided for personnel safety. Terminals will normally not be disconnected for

servicing without advising the customer so that protection of the current source will be maintained.

5. Input Type: Floating differential, filtered current input using IBM Filter and Current Elements. (See Figure 37.)  
Input Impedance: 250 ohms without differential amplifier or 25 ohms with differential amplifier set at 0 to  $\pm 500$  mv range.  
Sampling Rate: 3 samples per second per point maximum. 100 points per second maximum.  
Input Range: 4 to 20 ma.  
Maximum Overload: -2 ma to +24 ma.  
Offset: 1 volt to ADC at 4 ma.  
Source Characteristic: High impedance current source.  
Filter Characteristics: Noise rejection ratio at 60 cps is 125:1. Time constant is .330 seconds (multiply by 10 for 99.97% stabilized response to signal changes).  
Common Mode Voltage: 200 volts maximum operating. 250 volts maximum safe.

#### DANGER

Where operating common mode voltage exceeds 48 volts, a means of disconnecting this source must be provided for personnel safety. Terminals will normally not be disconnected for servicing without advising the customer so that protection of the current source will be maintained.

### MULTIPLEXER/R COMMON MODE PERFORMANCE

In any data acquisition or control system, the accuracy of analog signal reading is limited by the analog error present in the system at the time of the reading. There are various sources of error in a given reading for any particular time and environment. These sources may be grouped into:

1. Basic System Error
2. Error Due to Noise
3. Error Due to Common Mode Voltages

The following text will consider briefly the first two sources of these errors, but is directed mainly toward an explanation of how high common mode rejection is achieved in the IBM 1800 Data Acquisition and Control System.

#### Basic System Error

The basic system error is the error which would occur in a noiseless system with no common mode

voltages. It is a combination of many small errors that various components in the analog input system contribute. The basic system error includes such things as:

1. Source loading error
2. Amplifier gain accuracy
3. Amplifier zero offset error
4. Amplifier gain stability
5. ADC comparator accuracy
6. ADC reference voltage accuracy
7. Multiplexer offset error

The purpose of the analog input portion of a control or data acquisition system is to measure the true output of some device. In reality, the signal presented to the analog input system includes the true signal plus other signal components. In a generic sense, these other signal components are noise and would therefore normally include the signal component caused by applied common mode voltages. For our purpose, it is convenient to restrict the definition of noise to exclude signals caused by common mode potentials. Therefore, noise is that part of a signal which is not accounted for either by common mode errors or by the true output of the device being measured.

#### Error Due to Noise

There are many sources of noise -- some ac and some dc. A common example is 60 cycle "hum" induced on the signal lines by nearby power sources. Other examples are: thermoelectric potentials (thermal e.m.f.); transient spikes due to motor commutators, silicon controlled rectifiers, switches, relays, and circuit breakers; high frequency interference due to radio or radar stations. If a signal contains excessive noise, the readings on a given point will vary between relatively wide limits. The "spread" of readings indicates the severity of the noise. The effects of noise can be reduced by averaging several readings taken from the same source in a short period of time. The true solution (although not always possible) to a noise problem is the elimination of the noise source. Sometimes this can be done by physical and electrical isolation, shielding, filtering, and in general, adherence to good instrumentation practices.

#### Error Due to Common Mode Voltages

The existence of common mode voltages can be a source of major error in some systems. A common

mode voltage is the voltage that can be measured between a reference point (system ground) and both input terminals. For example, in Figure 38, if voltmeter 1 reads 5.00 volts and voltmeter 2 reads 5.05 volts, then the common mode voltage is 5.0 volts and the signal or differential voltage is 0.05 volts.

Common mode voltage can result from several phenomena. Some devices to be measured have "built-in" common mode; this is almost always true of bridge circuits, for example. Another source is current flow through the ground resistance between system ground and the point at which the device being measured is grounded.

The mere existence of a common mode voltage does not appear to be an error and, theoretically, it is not an error. In practice, however, a portion of the common mode voltage is "converted" to a differential signal which adds to the true signal. The process of converting common mode to differential (normal) mode in any given system is very complex due to the distributed leakages and capacitances in an actual system. It is possible, however, to gain insight into the conversion mechanism by considering the highly simplified dc model of the analog input system shown in Figure 39.

In the model we assume that a thermocouple is being measured by a perfect measuring system. The true signal voltage is assumed to be zero for simplicity. The resistance  $R_1$  is the resistance of one input line and the other line is assumed to have negligible resistance. The resistances  $R_2$  represent leakage resistances to system ground. In practice, these resistances would rarely be equal, but the assumption of equality simplifies the analysis. The common mode voltage is represented by the battery  $V_{cm}$ .

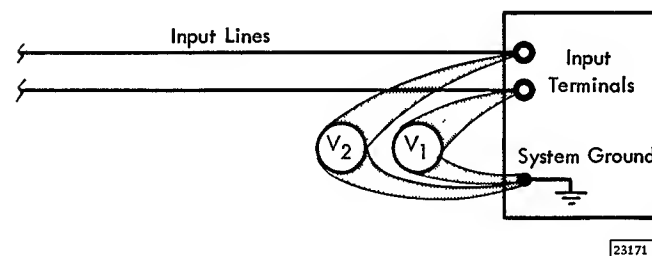


Figure 38. Common Mode Measurement

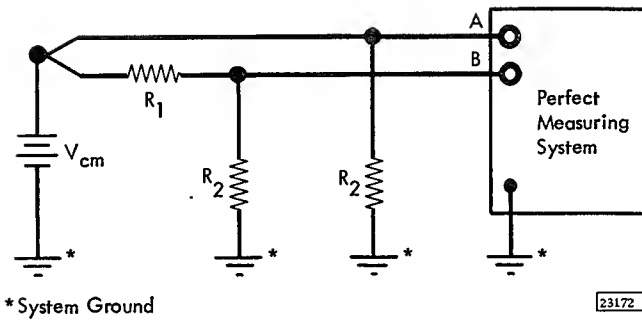


Figure 39. Common Mode Conversion Model

The voltage  $V_A$  at terminal A is equal to  $V_{cm}$ . The voltage  $V_B$  at terminal B is determined by the voltage divider consisting of  $R_1$  and  $R_2$ . Thus, the voltages  $V_A$  and  $V_B$  are:

$$(1) \quad V_A = V_{cm}$$

$$(2) \quad V_B = \frac{R_2}{R_1 + R_2} V_{cm}$$

The voltage measured by the perfect measuring system is the difference between  $V_A$  and  $V_B$ . If  $V_{sig_{cm}}$  represents the "converted" common mode voltage, then:

$$(3) \quad V_{sig_{cm}} = \left(1 - \frac{R_2}{R_1 + R_2}\right) V_{cm}$$

or:

$$(4) \quad V_{sig_{cm}} = \frac{R_1}{R_1 + R_2} V_{cm}$$

This is a finite, non-zero voltage. Thus, even though the true signal is zero, a potential equal to that given by (4) will be measured. This is a common mode error. A similar analysis can be performed for ac common mode except that stray capacitance must also be considered.

From a system standpoint, the common mode error cannot be distinguished from a true signal nor can the system compensate for this error. It is obvious, therefore, that common mode errors due to conversion which occurs in the plant instrumentation or customer wiring will contribute an additional error. Therefore, the system common mode performance specification indicates the conversion which occurs within the system between the input terminals and the measuring device (ADC).

## Design for High Common Mode Performance

The expression given as (4) also forms the basis for a philosophy of design which is used in designing systems subject to common mode voltages. The expression shows that the error  $V_{sig_{cm}}$ , can be reduced by either reducing  $R_1$  or by making  $R_2$  much larger than  $R_1$ . If a more complex model is used, it can also be shown that common mode errors can be reduced by balancing the two line resistances and the two leakage resistances. In a system with many inputs, this balancing approach is impractical because of the labor involved in performing the balance and the difficulty in maintaining the balance over time and temperature. Similarly, reduction of  $R_1$  is impractical because the input lines have a finite resistivity which may be quite high, as for example, in an iron-constantan thermocouple.

The approach used most often in present systems and instrumentation amplifiers is to design the system so the effective value of the leakage resistance  $R_2$  is very high. Typically, effective resistances of thousands of megohms can be achieved in instrumentation amplifiers. Because of the complexity of a large data acquisition system, the effective resistances which can be achieved in a system are somewhat less than this.

Another approach to minimizing common mode errors is to design a system in which the common mode source is disconnected for the period during which the particular input is being measured. The configuration which is based on this principle and being used in the IBM 1800 Data Acquisition and Control System is shown in Figure 40. In the figure

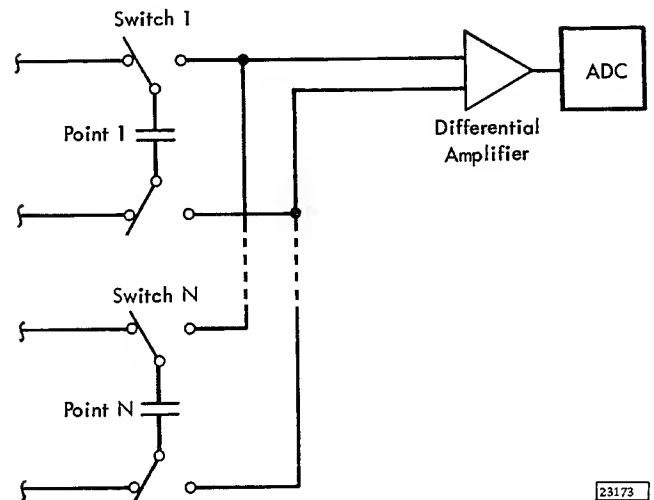


Figure 40. Basic Analog Input Configuration

inputs are assumed to be low level signals (less than one volt). The system is the same for high level differential inputs (0-5 volts) except that the differential amplifier is not used.

The signals to be measured are connected to points 1 through N. The signal voltages charge the capacitors  $C_1$  through  $C_N$  to a voltage equal to the average value of the signal. Assuming random noise, this average value is equal to the voltage to be measured. The switches (Switch 1 to Switch N) are two pole double throw mercury-wetted relays which have a break-before-make characteristic, and in fact, both poles of the relay break before either pole makes on the back contact. The development of a mercury wetted relay with this characteristic was important in the application of this principle of common mode rejection.

When an address is selected, the relay disconnects the capacitor from the input and connects it to the amplifier-ADC for the few milliseconds required for measurement. The input impedance of the amplifier is high enough that the capacitor discharge is negligible during the measurement period.

In this system, a common mode source connected to an input is never applied to the actual measuring system. Thus, the amplifier is not required to have a high common mode rejection capability. Conversion from common mode to differential mode can occur at any point in the analog path before the relay and thus can contribute to common mode error. This error can be minimized by careful installation design and practice.

### Stray Capacitive Effects

On the basis of the simplified common mode analysis given previously and the above description of the "flying capacitor" system, it might appear that the only common mode error is that caused by conversion prior to the relay. This is not correct, since some common mode error is generated at the amplifier; but, the mechanism is quite different from that described previously. In this case, the error is caused by various stray capacitances in the system sharing the charge.

To consider the mechanism of charge sharing in more detail, a single relay and its stray capacitances is shown in Figure 41.

The capacitance  $C_n$  is the "sampling capacitor" shown in Figure 41.  $C_1$  and  $C_2$  are many orders of magnitude smaller than  $C_n$ . The capacitances  $C_3$  through  $C_7$  are other stray capacitances that exist in the system, with  $C_5$  being caused mainly by the input capacitance of the amplifier.

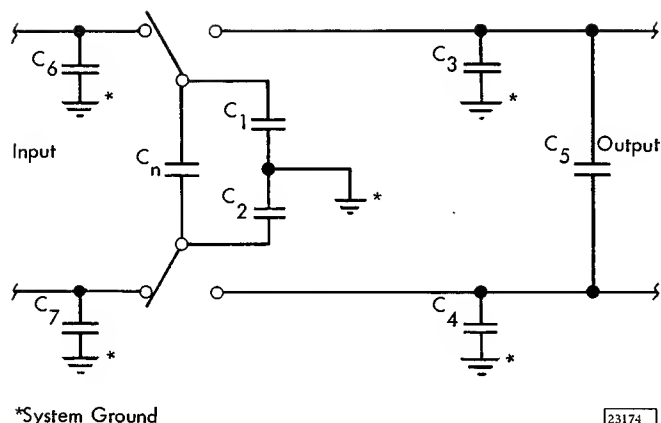


Figure 41. Relay and stray Capacitance

If common mode is applied to the system, the capacitances  $C_1$ ,  $C_2$ ,  $C_6$ , and  $C_7$  are charged to the common mode voltage; whereas  $C_n$  is charged to the signal voltage (if any). Thus each capacitance is storing an amount of charge proportional to its value. When the capacitors  $C_n$ ,  $C_1$ , and  $C_2$  are transferred from the input circuit to the output circuit, the stored charge on these capacitors and the charge stored on capacitors  $C_3$ ,  $C_4$ , and  $C_5$  redistribute themselves. This redistribution results in charge being added to or taken away from the charge stored on  $C_n$ . Since the voltage across  $C_n$  is dependent on the charge stored on  $C_n$ , this voltage will change. This change represents an error in the signal.

By appropriate selection of the value of  $C_n$  and by careful design to minimize stray capacitances, the error introduced by charge sharing can be made quite small. Thus, the influence of common mode voltage is minimized and the system common mode performance (common mode rejection ratio) is enhanced.

As indicated in the previous analysis, the exact calculation of common mode performance is extremely difficult, due to the complexity of the system as a distributed network. However, by using approximate models, it is possible to evaluate the common mode performance of the flying capacitor approach. These theoretical calculations indicate a system common mode performance which is appreciably better than can be obtained using a standard amplifier approach. Actual system testing under a variety of environmental conditions substantiates these calculations and verifies the mathematical model.

The flying capacitor approach offers other potential advantages. Since the input is disconnected when the signal value is actually being



measured, a transient noise pulse at the input terminals is less likely to cause an error. In addition, the design of the amplifier is simplified because its inherent common mode rejection capability need not be as high. In many systems, the maximum allowable common mode voltage is limited to approximately 20 volts because of the breakdown voltage limitations on a differential amplifier. In the flying capacitor system, the common mode voltage is never applied directly to the amplifier.

This means that the maximum allowable common mode voltage is limited only by the breakdown characteristics of the terminals and relays which are generally greater than 500 volts.

## MULTIPLEXER/R INSTALLATION PRACTICES

The multiplexer/R inputs have been designed to provide maximum isolation from the noise sources that affect analog performance. This is accomplished by providing a completely floating input into the system and the system ground. A capacitor in the relay circuit becomes charged to the input value, and, upon sampling, is disconnected from the input source. This charge value is read by the ADC. The charge rate of the capacitor depends on the source resistance, including filters. Where the rate of change of the source signal permits a reduced sampling rate, the customer is advised to use the filter element which affords maximum attenuation of noise on the analog signal. The availability of the custom elements permits the ready installation of other filter, voltage divider, or conditioning networks.

To minimize the presence of noise on the input signal lines, the customer should utilize twisted pair wiring. Where the lines are expected to traverse regions of high electric field strength, it may be advantageous to use shielding. Shielding, when used, should be insulated and grounded at only one point -- preferably at the signal source.

Despite a high common mode rejection capability, performance can generally be improved in one of two ways. Either securely ground, or completely insulate and shield the signal source. Route the signal wiring by the most direct route, avoiding regions of electric field strength (obviously present around power lines, motors, switch gear, or higher

level signal lines), keeping to a minimum the unbalance associated with differences in resistance between each side of the signal pair (thermocouple extension wire), and keeping all connections secure.

Thermocouple signals that utilize the reference temperature measuring capability of the 1851 model 2 should use a continuous splice-free section of homogeneous twisted pair extension wire between the thermocouple head and the 1851 terminals. Even when better grades of extension wire are used, it is not advisable to route the wiring through regions of greatly varying temperature when maximum accuracy of measurement is desired. When using low level signals, minimum distance and quality insulation (such as Teflon\* or polyethylene) should be used to minimize losses. Since certain grades of insulation deteriorate in the presence of moisture and corrosive atmospheres, insulation should be selected accordingly.

### Open Circuit Detection

On multiplexer/R input paths that do not include a voltage element, a current element, or a similar customer supplied network (Figure 37), the following should be considered during the system design stage. If the input transducer circuit should become open (as in the case of a thermocouple burning out) while in the unselected state, the "Flying Capacitor" does not have a discharge path and the open circuit will not be detected. An RPQ is available, if open circuit detection is desired, or the customer may provide a network that is compatible with his input and the dynamics of the process variable being measured.

## MULTIPLEXER/S SPECIFICATIONS

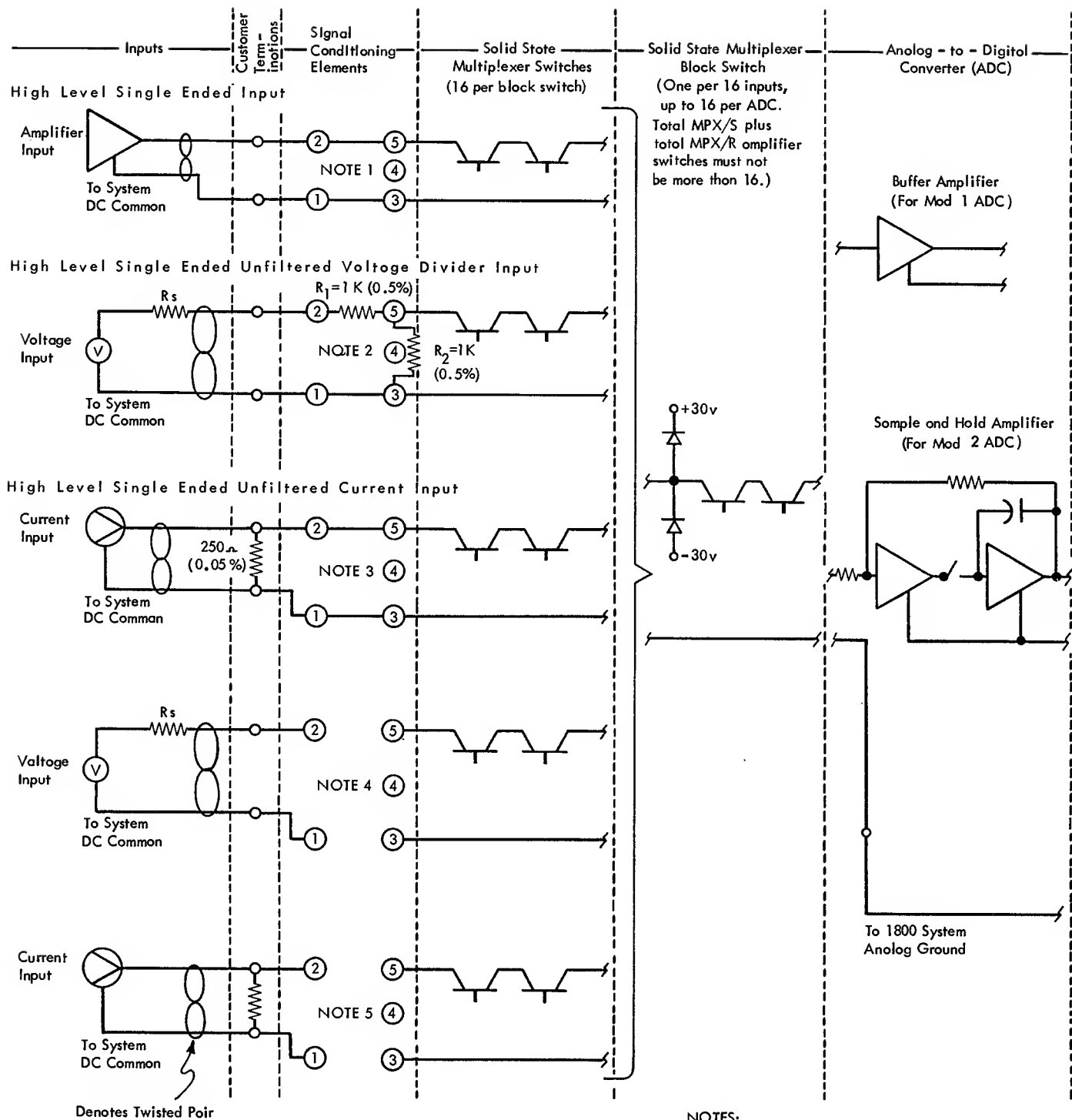
### Input Types

The three input types that follow are illustrated in Figure 42.

1. Input Type: High level single ended, unfiltered voltage input (Connector Element).  
Input Impedance: With mod 1 ADC - 10 megohms (minimum), 1000 pf.  
With mod 2 ADC - 0.1 megohms ( $\pm 0.05\%$ ), 1000 pf.  
Unselected switch impedance is 350 megohms (minimum), 40 pf.

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\*Trademark of E. I. du Pont de Nemours Company



NOTES:

1. Multiplexer matching cord (Connector Element).
2. Multiplexer/S Voltage Element.  $\frac{R_2}{R_1} = 1 \pm .02\%$
3. Multiplexer matching cord (Connector Element) plus Current Element.
4. Custom Element (customer network or RPQ).
5. Custom Element plus Current Element.

23166D

Figure 42. Solid State Multiplexer Inputs

Input Range:  $\pm 5$  volts.

Maximum Overload:  $\pm 34$  volts dc or peak ac.

Overload voltages are clamped to  $\pm 30$  volts.

Zero Offset: Adjustable to zero.

Source Impedance: Mod 1 ADC: 1k ohm maximum (including transmission line) to meet stated accuracy; refer to Specifications Summary, Table 2. Mod 2 ADC: 1 ohm (including transmission line) to meet stated accuracy; refer to Specifications Summary, Table 2. Higher source impedances require consideration of voltage divider error and transient error using input impedances stated previously.

Mod 1 and 2 accuracy specifications are based on the ability of the input to settle to within 0.01% of its final value within 4 microseconds after being multiplexed.

Common Mode Voltage: No common mode voltage rejection capabilities.

2. Input Type: High level single ended, unfiltered voltage divider input (Voltage Element).  
Input Impedance: 2000 ohms  
Input Range:  $\pm 10$  volts.  
Maximum Overload:  $\pm 68$  volts dc or peak ac.  
Overload voltages are clamped to  $\pm 60$  volts.  
Zero Offset: Adjustable to zero.  
Source Impedance: 1 ohm maximum (including transmission line) to meet stated accuracy; refer to Specifications Summary, Table 2. Known source impedance up to 150 ohms can be program compensated.  
Common Mode Voltage: No common mode voltage rejection capabilities.
3. Input Type: High level single ended, unfiltered current input (Connector and Current Elements).  
Input Impedance: 250 ohms.  
Input Range: 4 to 20 ma  
Maximum Overload:  $\pm 136$  ma.  
Offset: 1 volt to ADC at 4 ma.  
Source Characteristic: High impedance current source.  
Common Mode Voltage: No common mode voltage rejection capabilities.

## MULTIPLEXER/S INSTALLATION PRACTICE

All multiplexer/S inputs are single-ended circuits. This means that they have a single multiplexer switch in the "hot" (high) side of the input pair, while the "cold" (low) side is common to the system dc common. For this reason, all signal sources connected to multiplexer/S inputs should not be grounded at the source location. A twisted pair wire should be run from each (isolated) source to

the MPX/S terminal unit. If this wire must traverse regions of high electric field-strength, it will be advantageous to shield the wiring, insulate the shield from ground and connect the shield to ground at one of the following points (listed in order of preference):

1. At the single source if available.
2. To system dc common (negative input terminal).
3. To system frame ground.

Figure 43 illustrates the complications that can arise if grounded or single-wire sources are used on MPX/S.

Part A of Figure 43 shows a single-wire input for which the difference between the two ground potentials is algebraically added to the signal. Part B of the figure shows a single grounded input for which the ground current flow through line distributed impedance produces an error voltage in series with the signal and also causes noise on the analog ground system. The noise can be coupled into other input circuits through the ground system distributed impedance. Part C of the figure shows a further exposure to ground current flow between different sources through the system common lines if more than one remotely grounded input is used.

The unselected multiplexer/S point has an input impedance greater than 350 megohms; the selected point has an input impedance of 10 megohms in parallel with 1000 picofarads using the ADC mod 1 or an input impedance of 0.1 megohms in parallel with 1000 picofarads using the ADC mod 2. This transient switching condition on the output of an amplifier (when using high-level single-ended input as shown in Figure 42) may cause the amplifier to become unstable during the transient period resulting in damped oscillation that may not decay during the time the multiplexer point is selected. Some amplifiers have the capability to withstand this dynamic load switching while others do not. Of those that do not, some have the capability to be preloaded to reduce the effects. When choosing an input amplifier, the amplifier (plus preload, if required) should have the capability to perform as indicated under "Source Impedance" if system specifications are to be met.

The general family of chopper-stabilized amplifiers is usually not suitable for multiplexer applications. When a chopper-stabilized amplifier is subjected to transients, the recovery time of the amplifier will generally be longer than the time allowed for multiplexing. This is due to the large capacitances used in the amplifier.

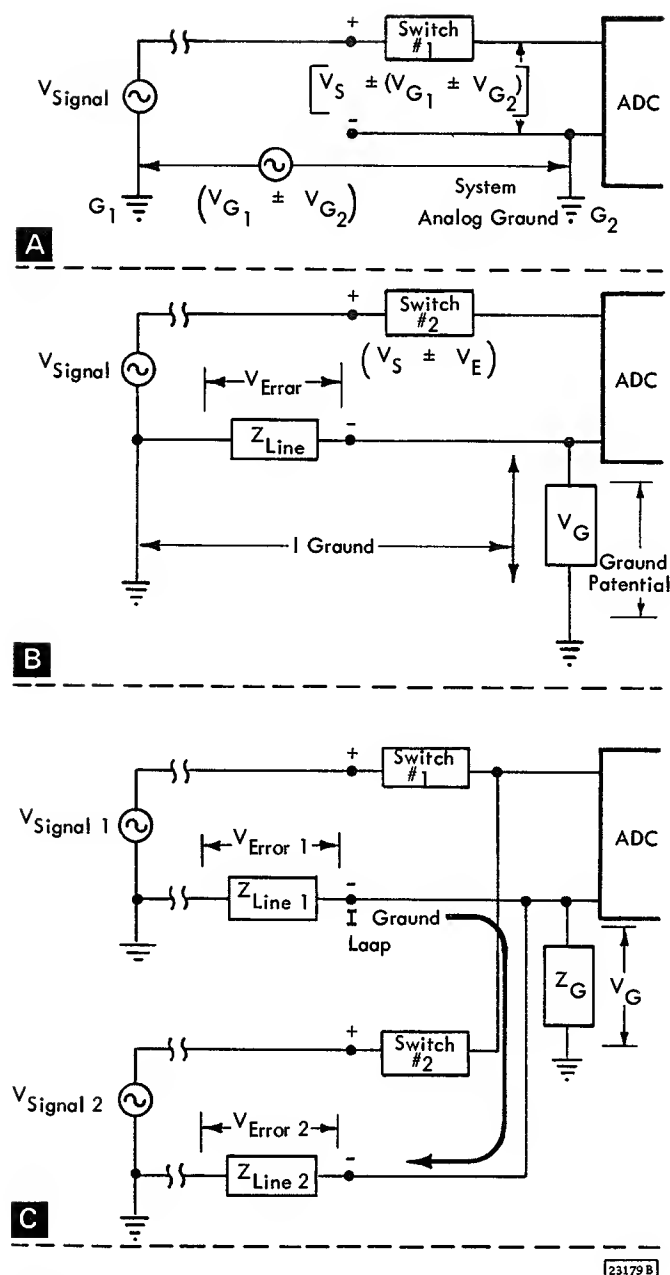


Figure 43. Complications of Single-Wire and Grounded Sources used with Multiplexer/S

### Multiplexer/S Grounding Practice

The multiplexer/S ADC inputs contain no common mode voltage rejection capabilities. Therefore, for best system performance, it is imperative that correct grounding procedures be observed. The following practices should be followed:

1. The signal source should be isolated from ground, and should be referred to the dc common input.

2. The ground line should be at least equal in size to the signal input line.
3. The signal and ground line should be kept as short as possible.
4. No impedance, other than that of the line itself, should be placed in the ground line.
5. The ground line should be isolated as much as possible from other current carrying lines. The amount of isolation should be greater than 1,000,000 to 1. Less than 100 microvolts should appear on the output for 125V ac power. Optimum results would be achieved with greater than 1 giga ( $10^9$ ) ohm of isolation.

### EXTERNAL SYNCHRONIZATION

Synchronization facilities for externally timing the sampling and digital conversion of an analog input signal are a basic part of the 1801, 1802, 1826 model 1 with Analog Input Expander, or the 1827.

A ready condition is transmitted to the customer's external device. The external device provides a "sync" pulse that causes the analog input controls to complete the action of selecting a multiplexer point by performing an analog to digital conversion and bringing down the ready signal.

Termination for the "sync" signals are in the processor-controller.

An additional mode of external synchronization can be employed by use of process interrupts. The processor-controller can be programmed so that recognition of an interrupt will cause action on any input point.

### "Ready" Signal Specifications

1. Down Level: -12 volts through a 1000 ohm resistor.
2. Load Requirements: 50 ft. transmission line (maximum).
3. Up Level: (Indicates Ready Condition) +0.0 to -0.5V dc.
4. Terminal and Circuit Description: Figure 44.
5. Wiring Practice: A single conductor shielded cable should be used for wiring to the "Ready" terminals. The shielding should be grounded to 1800 system ground at the terminal provided.

### "Sync" Signal Specifications

1. Up Level: -0.5 to +0.5V dc. The data channel adapter starts on a positive going transition.
2. Down Level: -6 to -18V dc.
3. Pulse Form:  
Minimum up level: 2 microseconds  
(maximum 15  $\mu$ sec).

Down level: 2 microseconds minimum before next positive going transition.

Rise and fall time not critical.

4. Timing (Mpx/R only): To maintain system accuracy the sync signal must occur within 0.33 seconds following the ready signal.

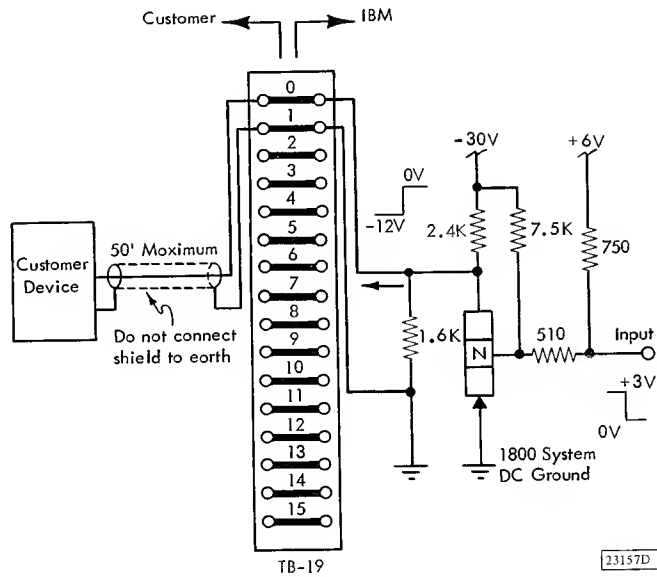


Figure 44. Analog Input "Ready" Signal, Terminal and Circuit Schematic (simplified)

5. Load Requirements: 50 ft. transmission line (maximum).
6. Terminal and Circuit Description: Figure 45.
7. Wiring Practice: A single conductor shielded cable should be used for wiring to the "Sync" terminals. The shielding should be grounded to the 1800 system ground at the terminal provided.

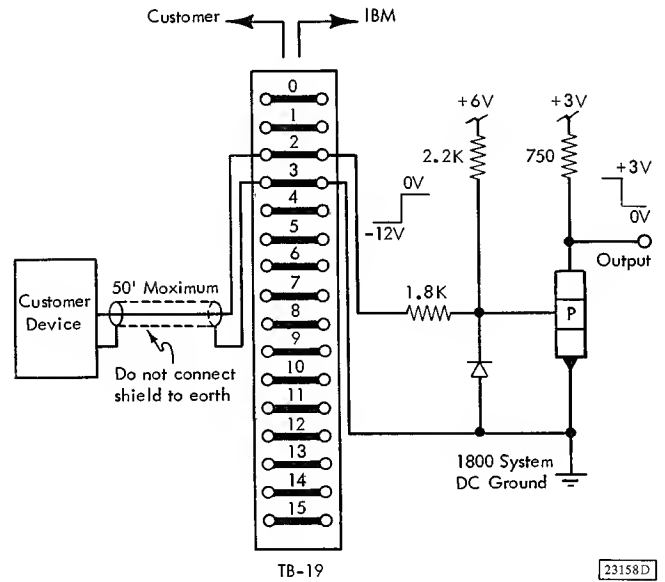


Figure 45. Analog Input "Sync" Signal, Terminal and Circuit Schematic (simplified)

## SECTION 5. SPECIFICATIONS SUMMARY

### PROCESS I/O TERMINATION

Process inputs and outputs can be generally classified into four types: Analog input, digital input, analog output, and digital output. Table 1 provides the external synchronization specifications to be used when external synchronization is used with any process I/O feature. Tables 2, 3, 4, and 5 list the electrical and physical termination requirements for the Process I/O features.

#### Termination Type

Terminations are 2-wire screw-down or binding posts designed to accommodate all standard sizes up to AWG #14 (2,082 mm<sup>2</sup>) of customer-provided and installed two-wire cabling. Except for differential analog inputs, all inputs and outputs are single-ended and are referenced to a common system ground which is provided as one of the two terminals for each I/O point.

Terminations are located in a designated customer access area at the rear of each unit in which the individual feature is housed. Vertical channeling is provided in the customer access areas for routing wiring from both top and bottom entries.

#### Recommended Wiring Practices

Two-wire twisted pair is recommended for all customer signal wiring (except "sync" and "ready" signals which must be single conductor, shielded). Shielding may be used, particularly where physical separation between signal wiring of different functions cannot be obtained or a run must parallel electrical power wiring, or, where unfiltered high speed signals are involved.

Provisions for switching, tiedown, and grounding of shields must be provided by the customer or by special order (RPQ) if desired for a particular installation.

All cross-overs of signal wiring with electrical power wiring in the installation should be at right angles. All signal wiring should take the most direct route, with a physical separation of two feet or more between electrical power wiring. Remove excess wiring.

Select insulation and overwrap to provide protection against the elements which will be encountered in a particular wiring run. Give specific attention to minimizing resistive, inductive, and capacitive

coupling with grounds and adjacent signal and power runs. Absorption of moisture, chemical reaction, or breakdown of poor insulation grades may cause serious system errors. Polyethelene insulation with PVC overwrap on multiconductor cables is recommended.

#### Recommended Wire Type

- Duplex Twisted (except external sync and ready where single conductor shielded wire is recommended).
- Multiple pair cable may be employed.
- Wire size and material to suit circuit parameters and strength requirements, stranded or solid.
- Polyethylene Wire Insulation or equivalent.
- Suitable overwrap for the application.
- Electrostatic Shield, foil type with copper drain wire (optional except on high speed or high accuracy signals).

### SYSTEM SPECIFICATIONS

Appendixes A and B are summaries of specifications for the IBM 1800 Data Acquisition and Control System. Plan views can be found in Section 3 and descriptions of each unit can be found in Section 2 of this manual.

Table 1. External Synchronization Specifications

	Sync (Supplied by Customer)	Ready
Input Voltage	Up: -0.5 to +0.5v Down: -6 to -18v	Up: 0.0 to -0.5 v Down: -12v
Durotion (Minimum)	Up: 2 $\mu$ sec Down: 2 usec	Pulse Level
Type of Termination	Screw-Down	Screw-Down
Recommended Wiring	Single Conductor Shielded, 50' Moximum	Single Conductor Shielded, 50' Moximum

15736 A

## ANALOG PERFORMANCE TERMINOLOGY

Definitions of the terms used in Tables 2 and 3 and in Figure 46 are listed in the following paragraphs. The figure and the tables are intended as a guide to 1800 performance.

**Accuracy:** An over-all quantity specifying the maximum deviation of the converted digital value from the true value. The values stated include all contributing factors such as linearity, crosstalk, offset, and internal noise from all features within the signal path, but do not include variations caused by temperatures in excess of a normal controlled environment ( $\pm 5^{\circ}\text{F}$  or  $\pm 2.8^{\circ}\text{C}$ ), time (over 24 hours), common mode, or external noise.

**Repeatability:** Represents the maximum deviation from the mean of converted values on the same input point within any 10 minute interval, but does not include variations caused by temperatures in excess of a normal controlled environment ( $\pm 5^{\circ}\text{F}$  or  $\pm 2.8^{\circ}\text{C}$ ), common mode, or external noise.

**Quantizing Error:** The finite resolution of the ADC is one Least Significant Bit (LSB). Calibration of an ADC allows centering of the digital crossover to produce  $\pm 1/2$  LSB quantizing error. This value must be added to the table value and is dependent on the ADC resolution used.

**Temperature Coefficient:** Represents the deviation attributed to variations in temperature. The slope

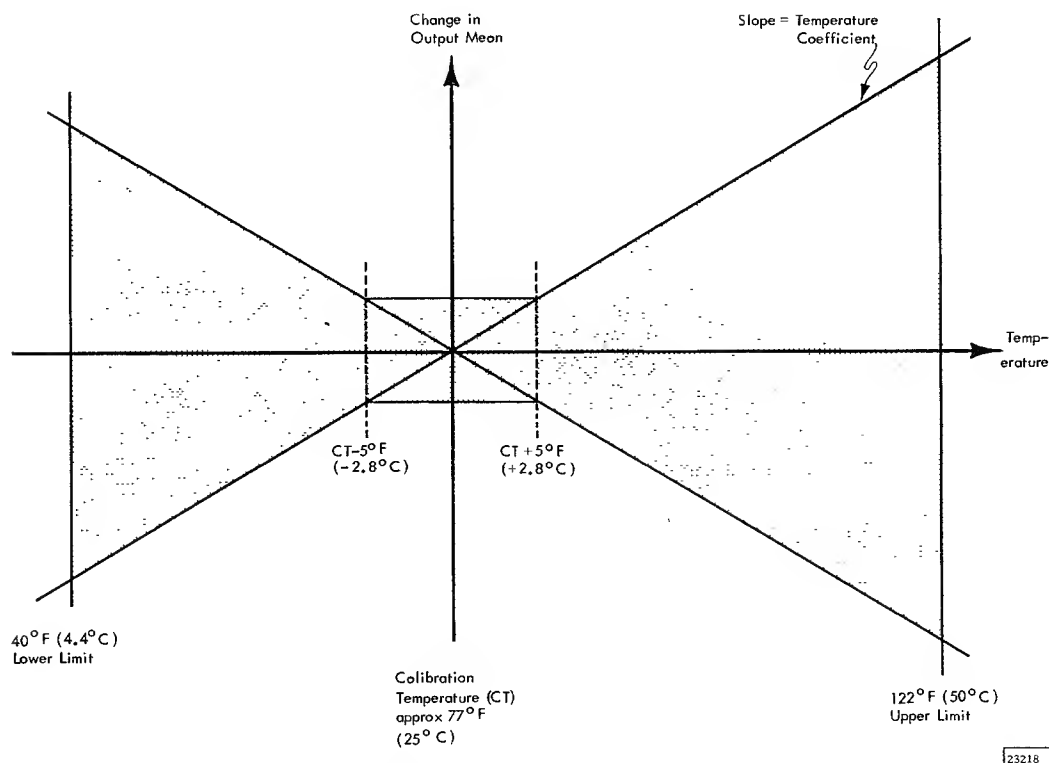


Figure 46. Temperature Coefficient Definition (See tables 2 and 3)

of the diagonal lines in Figure 46 represents the temperature coefficient. The mean value of the ADC readings for a constant input will remain within the shaded area (Figure 46) as the temperature changes.

Stability or Drift: Represents the maximum deviation of the statistical mean within a specified time at a constant temperature.

Common Mode Rejection Ratio (CMRR): This factor defines the change in the converted value resulting from external common mode potentials, when sampled at less than 3 samples per second per point. The CMRR values quoted are for dc, 60 cycle ac, and common mode crosstalk. The values apply

throughout the specified environment range of the 1800 system provided the 1851 remains sealed and the desiccant is maintained.

Notes:

1. Actual accuracy on any single reading is equal to the combined effects of:
  - Accuracy
  - Temperature
  - Drift
  - Common mode and normal mode noise
2. All specification parameters are expressed to the normal confidence limits of "three sigma".



Table 2. Analog Input Specifications

Multiplexer Type	Solid-State	Solid-State	Relay	Relay
ADC Mod	Mod 2	Mod 1	Mod 1 or Mod 2	Mod 1 or Mod 2
Filter Input Type (see note 2) Input Range Maximum Safe Input Common Mode, Operating Common Mode, Maximum Source Impedance, (see note 5) Source Unbalance, Maximum Conversion Rates (see note 6) Filter Time Constant (IRC) (see note 1)	None Single Ended 0 to $\pm 5v$ 50v Peak None None 1 $\Omega$ - (see note 6) None	None Single Ended 0 to $\pm 5v$ 50v Peak None None 1K $\Omega$ - (see note 6) None	Yes Differential 0 to $\pm 50$ mv (see note 3) + 6v/- 0.5v 200v Peak 250v Peak 1K $\Omega$ 1K $\Omega$ (see note 6) .330 sec	Yes Differential 0 to 5v (see note 4) + 6v/- 0.5v 200v Peak or Max dc 250v Peak or Max dc 1K $\Omega$ 1K $\Omega$ (see note 6) .330 sec
Termination	2 Wire Screw-Down	2 Wire Screw-Down	2 Wire Screw-Down or Binding Post	2 Wire Screw-Down or Binding Post
Recommended Wiring	Twisted Pair	Twisted Pair	Twisted Pair	Twisted Pair

## Notes:

- 1 Times 10 for 99.97% stabilized response to signal changes.
- 2 Single ended inputs share a common ground. Source signals must be isolated from additional grounds to avoid ground loops.
- 3 Amplifier gain adjustable to other ranges:  $\pm 10$  mv,  $\pm 20$  mv,  $\pm 100$  mv,  $\pm 200$  mv,  $\pm 500$  mv.
- 4 4-20 ma can be converted to 1 to 5v or 0.1 to 0.5v on relay and 1 to 5v on solid state.
- 5 Source Impedance voltage divider error and transient effects must be considered for higher values.  
(see discussion of Source Impedance)
- 6 In operation, the Mod 1 ADC will provide conversion rates up to 11,000 per second and the Mod 2 ADC will provide conversion rates up to 24,000 per second. These rates are possible only with certain system configurations and programming methods, and should not be considered as sustained system conversion rates. See IBM 1800 Functional Characteristics, Order No. GA26-5918 for further details.

## Relay Path - Input Ranges

Analog Input Performance Specifications (Total System Performance for typical systems input paths is given in percentage of full scale reading.)	± 10 mv	± 20 mv	+ 50 mv	± 100 mv	± 200 mv	± 500 mv	5v	Voltage or Current Element 500 mv
	Input Type - Multiplexer/R - ADC Mod 1 - Filter Element and Low Impedance Sources							
Accuracy ± 1/2 LSB * Repeatability ± 1/2 LSB * Temp. Coeff. (per degree F) Drift (6 months)	± .33 ± .24 ± .013 ± .16	± .18 ± .12 ± .008 ± .10	± .10 ± .06 ± .004 ± .06	± .08 ± .04 ± .003 ± .06	± .07 ± .04 ± .003 ± .06	± .07 ± .03 ± .003 ± .06	± .05 ± .03 ± .002 ± .03	± .11 ± .03 ± .003 ± .06
	Input Type - Multiplexer/R - ADC Mod 2 - Filter Element and Low Impedance Sources							
Accuracy ± 1/2 LSB * Repeatability ± 1/2 LSB * Temp. Coeff. (per degree F) Drift (6 months)	± .33 ± .24 ± .013 ± .16	± .18 ± .12 ± .008 ± .10	± .10 ± .06 ± .004 ± .07	± .09 ± .04 ± .003 ± .07	± .08 ± .04 ± .003 ± .06	± .08 ± .03 ± .003 ± .06	± .07 ± .03 ± .003 ± .05	± .12 ± .03 ± .003 ± .06
* Least significant bit Quantizing error    Note: The table values are rounded and include all readings on any analog point.	Input Type - All Low-Level Relay Paths With Filter Elements and Low Impedance Sources							
	Common Mode Rejection Ratio			77° ± 5° F (25° ± 2.8° C) Rel Humidity 40 to 60%		40° to 122° F (4.4° to 50° C) Rel Humidity 8% to 95% Max Wet Bulb: 85° F (29.4° C)		
	100 ohm unbalance			2 × 10 <sup>6</sup>		1 × 10 <sup>6</sup>		
	1000 ohm unbalance			1 × 10 <sup>6</sup>		0.5 × 10 <sup>6</sup>		
Multiplexer/S 5v Input		ADC Mod 1		ADC Mod 2		ADC Mod 1 Current Element		ADC Mod 2 Voltage Element
Accuracy ± 1/2 LSB * Repeatability ± 1/2 LSB * Temp. Coeff. (per degree F) Drift (6 months)		± .05 ± .03 ± .003 ± .03		± .06 ± .03 ± .003 ± .05		± .14 ± .03 ± .003 ± .04		± .63 ± .10 ± .008 ± .05

15731J

Table 3. Analog Output Specifications

	With Analog Driver Amplifier	
	DAC Mods 1 & 2	DAC Mods 3 & 4
Output Voltage	+ 9.990V	+ 9.998 to -10.000V
Input data	10 bits	13 bits + sign
Load (R) Minimum	1000 $\Omega$	1000 $\Omega$
Load (C) Maximum	2000 picofarads	2000 picofarads
Output Impedance	<0.6 $\Omega$ at dc	<0.6 $\Omega$ at dc
Accuracy	$\pm 0.25\%$ of full scale	$\pm 0.015\%$ of full scale
Stability (40 hours)	$\pm 0.01\%$ of full scale	$\pm 0.006\%$ of full scale
Stability (6 months)	$\pm 0.05\%$ of full scale	$\pm 0.016\%$ of full scale
Conversion Time (with max cap load)	10 $\mu$ s (to within 20 mV)	10 $\mu$ s (to within 10 mV)
Temperature Coefficient	$\pm 0.0017\%$ per degree F	$\pm 0.0011\%$ per degree F
Recommend Wiring	Twisted Pair	Twisted Pair

	Without Analog Driver Amplifier	
	DAC Mods 1 & 2	DAC Mods 3 & 4
Output Voltage	+ 4.995V maximum	+ 4.9994 to -5.000V
Input data	10 bits	13 bits + sign
Load Resistance	Must be included as voltage divider error in computing system accuracy	
Output Impedance	10,000 $\Omega$	10,000 $\Omega$
Accuracy	$\pm 0.2\%$ of full scale	$\pm 0.01\%$ of full scale*
Stability (40 hours)	$\pm 0.01\%$ of full scale	$\pm 0.005\%$ of full scale
Stability (6 months)	$\pm 0.05\%$ of full scale	$\pm 0.011\%$ of full scale
Temperature Coefficient	$\pm 0.001\%$ per degree F	$\pm 0.0005\%$ per degree F
Conversion Time (less than 60 picofarad load)	10 $\mu$ s (to within 10 mV)	10 $\mu$ s (to within 10 mV)
Conversion Time (with 500 picofarad load)	40 $\mu$ s (to within 10 mV)	40 $\mu$ s (to within 10 mV)
Recommended Wiring	Low Capacity - Shielded - Twisted Pair	

\*Refers to the accuracy of all readings on a single point. When multiple DACs are serviced by one PVR, the accuracy will be decreased. With a maximum of four Mod 4 DACs the accuracy is  $\pm 0.016\%$  of full scale.

- Notes: 1. Mods 1 and 2 use + 20 volt reference, PVR Mod 1  
 2. Mods 3 and 4 use  $\pm 20$  volt PVR Mod 2.  
 3. All outputs are commoned and referenced to system ground.  
 4. Accuracy is relative to Calibration of the Precision Voltage Reference.  
 5. Termination: Screw-down  
 6. The table values are rounded and include all readings on any analog point.

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Table 4. Digital Input Specifications

	Input Signal		
	Digital Input (Contact) Process Interrupt (Contact)	Digital Input (Voltage) Process Interrupt (Voltage)	Pulse Counter
Signal Duration Before Reading (Min)	4 ms On Closure 10 ms On Opening	2.5 ms, "One"*** 5.0 ms "Zero"***	100 $\mu$ s Up (5 kc Input Rate)
Signal Duration (Max)	—	—	None — Min. Off Or "Down Time" must Be 100 $\mu$ s
Source Resistance (Max) (Including Transmission Line)	1000 Ohms	*See Note Below	*See Note Below
Open Circuit Resistance (Min)	50,000 Ohms	*See Note Below	*See Note Below
Customer Voltage Limits Normal Operating	+36 vdc	Voltage Level At Terminals Binary "1": -1v To +30v Binary "0": -6v To -30v	Voltage Level At Terminals Binary "1": -1v To +30v Binary "0": -6v To -30v
Maximum Safe Voltage	120 vac	120 vac	120 vac
Type Of Termination **	2 Wire Screw-Down	2 Wire Screw-Down	2 Wire Screw-Down
Recommended Wiring	Twisted Pair	Twisted Pair	Twisted Pair
Notes: *Variable as long as normal operating voltage levels and signal durations are obtained at terminals. **Inputs are common to System ground. Avoid group loop conditions. ***If Optional High Speed (Digital Input, Voltage) is specified, minimum signal duration is 10 $\mu$ sec.			

15732 C

Table 5. Digital Output Specifications

	Output Signal		
	Electronic Contact Operate	Pulse Output	Register Out
Current Switched Maximum	.45 amp	.45 amp	32 ma (As returned to customer +3v)
Voltage Switched Minimum Maximum	+3v +48v	+3v +48v	Binary "1": +3v Binary "0": 0v
Line Termination Z	—	—	100 $\Omega$
Duration	Latching	Approx. 3 ms (program variable)	Latching
Type Of Termination	2 Wire Screw-Down plus power supply common	2 Wire Screw-Down plus power supply common	2 Wire Screw-Down
Recommended Wiring	Twisted Pair	Twisted Pair	16 Twisted Pair multiple conductor cable
	Power supply must be grounded only at system. Peak instantaneous voltage at the customers terminals must not exceed +65v or drop to less than +1v. R, L, and C characteristics must be adjusted to meet this criteria.		Common signal ground reference on output to system ground.

15733 C

# APPENDIX A. SUMMARY OF SPECIFICATIONS

Type	Model	Name	Electrical		Environmental		Weight (lbs)	Dimensions (inches)			Service Clearances (inches)				Notes
			kVA	Conn. Type*	BTU/hr.	ft <sup>3</sup> /min		Width	Depth	Height	F	R	L	Rt	
1053	3	Printer	0.1	G or H	335	-	35	23	11.5	9	12	12	12	12	
1054	2	Paper Tape Reader	0.1	-	335	-	20	22.75	13	6.6	12	12	12	12	1
1055	2	Paper Tape Punch	0.1	-	335	-	26	15.38	17.13	8.25	12	12	12	12	1
1442	6 & 7	Card Read-Punch	0.7	-	1,800	50	520	43	24	49	36	30	18	6	1
1443	1 & 2	Printer	1.1	-	2,450	416	731	55.9	43	46	36	36	30	36	1
1627	1	Plotter	0.1	-	375	-	33	18	15	10	12	12	12	12	1
1627	2	Plotter	0.1	-	375	-	55	40	15	10	12	12	12	12	1
1801	-	Processor-Controller	3.0	E	9,500	650	2,000	62	33	76.5	36	36	30	30	4,6
1802	-	Processor-Controller	3.0	E	9,500	650	2,000	62	33	76.5	36	36	30	30	4,6
1803	-	Core Storage Unit	0.7	-	1,800	490	968	32	33	76.5	36	36	30	30	3,4
1810	A1 & B1	Disk Storage	0.83	-	2,840	150	850	32	33	76.5	36	36	32	32	1
1810	A2 & B2	Disk Storage	1.16	-	3,960	225	930	32	33	76.5	36	36	32	32	1
1810	A3 & B3	Disk Storage	1.5	-	5,120	300	1,010	32	33	76.5	36	36	32	32	1
1816	-	Printer-Keyboard	0.1	G or H	335	-	65	23	19.75	9	12	12	12	12	
1826	1	Data Adapter Unit	1.5	-	4,600	490	968	32	33	76.5	36	36	30	30	2,3,4
1826	2	Data Adapter Unit	0.8	-	2,500	490	968	32	33	76.5	36	36	30	30	3,4
1826	3	Data Adapter Unit	0.7	-	1,800	490	968	32	33	76.5	36	36	30	30	3,4
1827	-	Data Control Unit	3.3	E	9,140	490	1,000	32	33	76.5	36	36	30	30	3,4,6
1828	1	Enclosure	-	-	-	-	642	32	33	76.5	36	36	30	30	4
1828	2	Enclosure	-	-	-	-	567	32	33	76.5	36	36	30	30	4
1851	1 & 2	Multiplexer Term	Nil	-	Nil	-	88								
1856	1 & 2	Analog Output Term	0.4	-	1,160	490	140								
2311	-	Disk Storage Drive	0.75	-	2,000	100	390	30	24	38	36	36	30	30	
2401	1,2 & 3	Magnetic Tape Unit	1.6	-	3,500	500	800	30	29	60	36	36	30	30	1
2402	1,2 & 3	Magnetic Tape Unit	3.2	-	7,000	1,000	1,600	60	29	60	36	36	30	30	1
2841	-	Storage Control Unit	1.1	D	3,100	1,000	750	32	45.5	60	30	30	48	30	

\*Connector type specifies the IBM-supplied power-cord plug, the customer-provided receptacle (or in-line connector), and the branch circuit specifications.

Conn. Type	Plug ‡	Receptacle ‡	In-Line Connector ‡	Branch Circuit				Phase Distribution for 1801/1802 Powered Units	
				Voltage	Amps.	Phase	Wires †	Type	Phases Used
D	Russell & Stoll FS3760	Russell & Stoll FS3754	Russell & Stoll FS3934	208/230	30	3	4	1054	1,3
E	Russell & Stoll SC7328	Russell & Stoll SC7324	Russell & Stoll SC7428	208/230	60	3	4	1055	1,3
G	Pass & Seymour #5266	Pass & Seymour #5261 or #5262	Pass & Seymour #5269	115	15	1	3	1442	2,3
H	Hubbell #5666	Hubbell #5661	Hubbell #5669	208/230	15	1	3	1443	2,3
								1627	1,3
								1803	1,2
								1810	1,3
								1826	1,2,(3)
								1828	1,2,(3)
								2401/2	1,2,3
‡ IBM supplies the listed (or equivalent) plug. The customer provides the listed (or equivalent) receptacle or connector.								Phase Distribution for 2841 50/60 Hz at 195/200/208 220/230/235V	
† Includes equipment ground (green) wire. See primary Electrical Power Requirements for details.								1st 2311	1, 2
								2nd 2311	1, 3
								3rd 2311	2, 3

## Notes:

- Power supplied by 1801/1802. Add kVA of attached units. Single phase loads are distributed on 3 phase primary power input at 1801/1802.
- KVA = 1.6 without AI Expander, BTU = 4250 without AI Expander.
- ft<sup>3</sup>/min and Weight with all features installed.
- Right and left service clearance when not abutted to another unit of the system.
- The three-phase power receptacle (customer's outlet) must be wired for proper phase rotation. As viewed from the face of the receptacle and counting counterclockwise from the grounding pin, the sequence will be phase one, phase two, and phase three. Phases 1 and 2 are for the first unit, phases 1 and 3 for the second, phases 2 and 3 for the third, etc. in rotation.
- This unit is equipped with radio frequency interference control circuitry and requires a good wired earth ground or an adequate building ground. Total resistance of the ground conductor, measured between the receptacle and the building ground point, may not exceed 3 ohms. For proper operation, all components of the system must have the same ground reference. Conduit is not an adequate means of grounding.
- Each Y phase connection is between the neutral (N) terminal and one of the three phases.

Y Phase Distribution for 2841 50 Hz at 380/408V	
1st 2311	N, 1
2nd 2311	N, 3
3rd 2311	N, 2

29132 F

# APPENDIX B. SUMMARY OF SPECIFICATIONS (METRIC)

Type	Model	Name	Electrical		Environmental		Weight (kg)	Dimensions (centimeters)			Service Clearances (centimeters)				Notes
			kVA	Power Card Style	kcal/hr	m <sup>3</sup> /min		Width	Depth	Height	F	R	L	Rt	
1053	3	Printer	0.1	G1	,084	-	16	58	29	23	30	30	30	30	1
1054	2	Paper Tape Reader	0.1	-	,084	-	9	57	33	17	30	30	30	30	1
1055	2	Paper Tape Punch	0.1	-	,084	-	12	39	44	21	30	30	30	30	1
1442	6&7	Card Read-Punch	0.7	-	,454	1,4	236	109	61	124	91	76	46	15	1
1443	1&2	Printer	1.1	-	,617	11,8	332	142	109	117	91	91	76	91	1
1627	1	Platter	0.1	-	,095	-	15	46	38	25	30	30	30	30	1
1627	2	Platter	0.1	-	,095	-	25	102	38	25	30	30	30	30	1
1801	-	Processor-Controller	3.0	E5	2,393	18,4	907	157	84	194	91	91	76	76	4,5
1802	-	Processor-Controller	3.0	E5	2,394	18,4	907	157	84	194	91	91	76	76	4,5
1803	-	Core Storage Unit	0.7	-	,454	14	439	81	84	194	91	91	76	76	3,4
1810	A1 & B1	Disk Storage	0.83	-	,716	4,2	386	81	84	194	91	91	81	81	1
1810	A2 & B2	Disk Storage	1.16	-	,998	6,4	422	81	84	194	91	91	81	81	1
1810	A3 & B3	Disk Storage	1.5	-	1,290	8,5	458	81	84	194	91	91	81	81	1
1816	-	Printer-Keybord	0.1	G1	,084	-	30	56	50	23	30	30	30	30	
1826	1	Data Adapter Unit	1.5	-	1,159	14	439	81	84	194	91	91	76	76	2,3,4
1826	2	Data Adapter Unit	0.8	-	,630	14	439	81	84	194	91	91	76	76	3,4
1826	3	Data Adapter Unit	0.7	-	,454	14	439	81	84	194	91	91	76	76	3,4
1827	-	Data Control Unit	3.3	E5	2,303	14	453	81	84	194	91	91	76	76	3,4,5
1828	1	Enclosure	-	-	-	-	291	81	84	194	91	91	76	76	4
1828	2	Enclosure	-	-	-	-	258	81	84	194	91	91	76	76	4
1851	1&2	Multiplexer Terminal	Nil	-	Nil	-	40	Mounts inside the 1828							
1856	1&2	Analog Output Term	0.4	-	,292	14	64								
2311	-	Disk Storage Drive	0.75	-	,504	3	177	76,2	61	96,5	91	91	76	76	6
2401	1,2&3	Magnetic Tape Unit	1.6	-	,882	14,2	362	76	74	152	91	91	76	76	1
2402	1,2&3	Magnetic Tape Unit	3.2	-	1,764	28,3	725	152	74	152	91	91	76	76	1
2841	-	Storage Control Unit	1.1	D2	,781	28	340	81,3	115,6	152,4	76	76	122	76	6

## Notes:

1. Power supplied by 1801/1802. Add kVA of attached units. Single phase loads are distributed on 3 phase primary power input at 1801/1802.
2. KVA = 1.6 without AI Expander. kcal = 1071 without AI Expander.
3. Weight and m<sup>3</sup>/min with all features installed.
4. Right and left service clearances when not abutted to another unit of the system.
5. This unit is equipped with radio frequency interference control circuitry and requires a good wired earth ground or an adequate building ground. Total resistance of the ground conductor, measured between the receptacle and the building ground point, may not exceed 3 ohms. For proper operation, all components of the system must have the same ground reference. Conduit is not an adequate means of grounding.
6. The 2841 provides single phase power to the 2311 units. Appendix A shows phase distribution.

Power Card Style	Service Size Rating *	Cable O.D.			Conductor	
		(in.)	(cm)	Shield	Quantity	Nominal O.D. (in.) (cm)
D2	30 amp, 3 phase, 5 wire	0.75	2,0	1	5	0.102 0,300
E5	60 amp, 3 phase, 5 wire	1.44	3,66	1	5	0.400 1,020
G1	15 amp, 1 phase, 3 wire				3	0.040 0,102

\* The number of wires includes one insulated grounding conductor (green with yellow trace).

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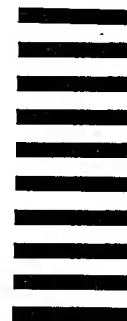
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